ROADS and STREETS

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Architects Drawing of the Bronx-Whitestone Suspension Bridge.

FIFTEEN THOUSAND MILES OF WIRE IN HIGHWAY SUSPENSION SPAN

Bronx-Whitestone Bridge Project Built in Record Time

THE Triborough Bridge Authority of New York under the chairmanship of Robert Moses is building a new suspension bridge across the East River in New York. The bridge will connect the Borough of the Bronx on the north with the Borough of Queens, Long Island, on the south and is known as the Bronx-Whitestone Bridge. It will provide a direct traffic route from New York State and New England to Long Island, eliminating the necessity of traveling several miles to the Triborough Bridge or other spans further south. The bridge also will furnish a direct approach to the New York World's Fair from the north and east and will be opened in time for the Fair.

General Description.—At the north and the approach in the Bronx begins at Eastern Boulevard and 177th St. Eastern Boulevard is a direct connection with the Boston Post Road from New England and with the Hutchinson River Parkway from Northern New York and New England. Extending south, the Bronx approach passes through a two hundred foot right of way for a mile and a quarter on grade to the viaduct structure leading to the bridge proper. From the beginning of the viaduct structure to the Bronx anchorage is a distance of 1825 ft. The suspended span of the East River bridge is 2,300 ft. between towers, with two side spans 735 ft. each between the towers and the anchorages. The Queens approach span is 938 ft. long similar to that in the Bronx. At the end of the bridge in Queens the project is constructed on grade for two miles, partly through a deep cut and partly over filled marsh. Three grade crossing eliminations are being constructed in this two mile stretch. At the southerly end the parkway and service roads are again brought together to cross Flushing River. The approach on the north side crosses over College Point Causeway, thereby eliminating one more crossing at grade. The structure over Flushing River is 1,800 ft. long over all and consists of approach structures on concrete piers with a double leaf bascule lift bridge in the center. On the south side of Flushing River another grade crossing elimination, designed as an elongated clover leaf, brings the project to its southerly terminus at Northern Boule-

vard in the Borough of Queens. Northern Boulevard is the northerly boundary of the New York World's Fair and provides direct access to Long Island's system of parkways and through traffic arteries.

Outstanding Features

Financing.—This entire project being constructed with private funds, $18,000,000 of bonds having been bought by private individuals.

Before the Authority reached a decision to finance and construct this project, a thorough study of traffic conditions and revenues that could be expected from the project was made. It was found that the anticipated revenue from toll charges was sufficient to meet construction costs and operating expenses. The Authority therefore decided to proceed with financing and construction.

The land for approaches was paid for jointly by the Authority and the city of New York, the former bearing 35 per cent of the cost and the latter 65 per cent. The city will receive the improvements on the approaches upon completion of construction.

Bridge Foundations.—The foundations for this bridge are the deepest for any bridge east of the Mississippi River. The two footings for the Bronx tower are 92.5 and 96.5 ft. below mean high water while those for the Queens tower are 142 and 144 ft. below mean high water respectively. The Queens anchorage, deepest of all footings, rests on rock at 163 ft. below mean high water.

Construction Program.—A normal program would allow three years for the construction of this bridge and its approaches but, through well timed and closely planned operations, the Authority will complete the project in two years.

It can readily be seen that a completely synchronized program is necessary to finish the project within the time set up. To this end, a schedule has been prepared, and maintained by constant supervision of the contractors' work. Work has proceeded without regard to weather or other "Acts of God." As a result, the program has been kept to the mark and there is every expectation that the project will be completed on time. In order to fulfill the program the contracts for foundations for the main bridge and steel erection of the towers were awarded in the same month in order to have the steel fabricated and ready for erection upon completion of the foundations. The cable and floor contract were awarded before the contract for approach piers for the same reason. All grading was completed this Spring and all paving is to be completed before winter. All small bridges will be completed before the paving, leaving only the main bridge, landscaping and incidental work to be completed next Spring. A total of about thirty contracts will have been awarded, some of the more important of which are as follows:

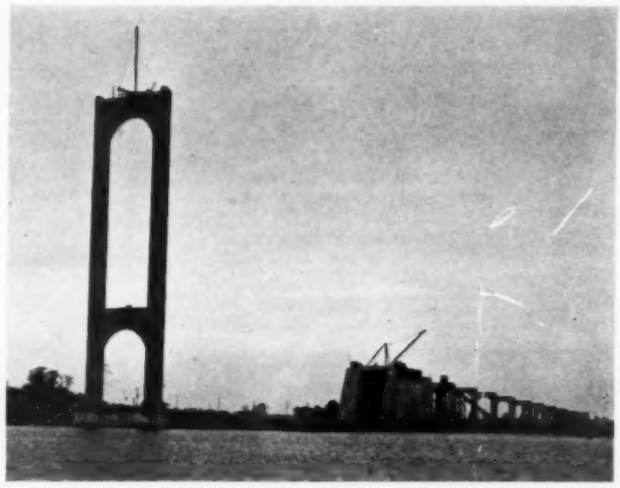
Main Bridge.—Foundations, Towers, Anchorages, Cables and Floor, Approach Piers and Raps.

Bronx Approach.—Grading and Paving, Fill, Paving on Fill, Parkway Lighting, Landscaping, Toll Buildings.

Queens Connection.—Grading and Drainage, Foundations at Flushing River, Superstructure at Flushing River, Grade Separation at Linden Street, Grade Separation at 20th Avenue, Grade Separation at 14th Avenue, Parkway Paving, Parkway Lighting, Landscaping.

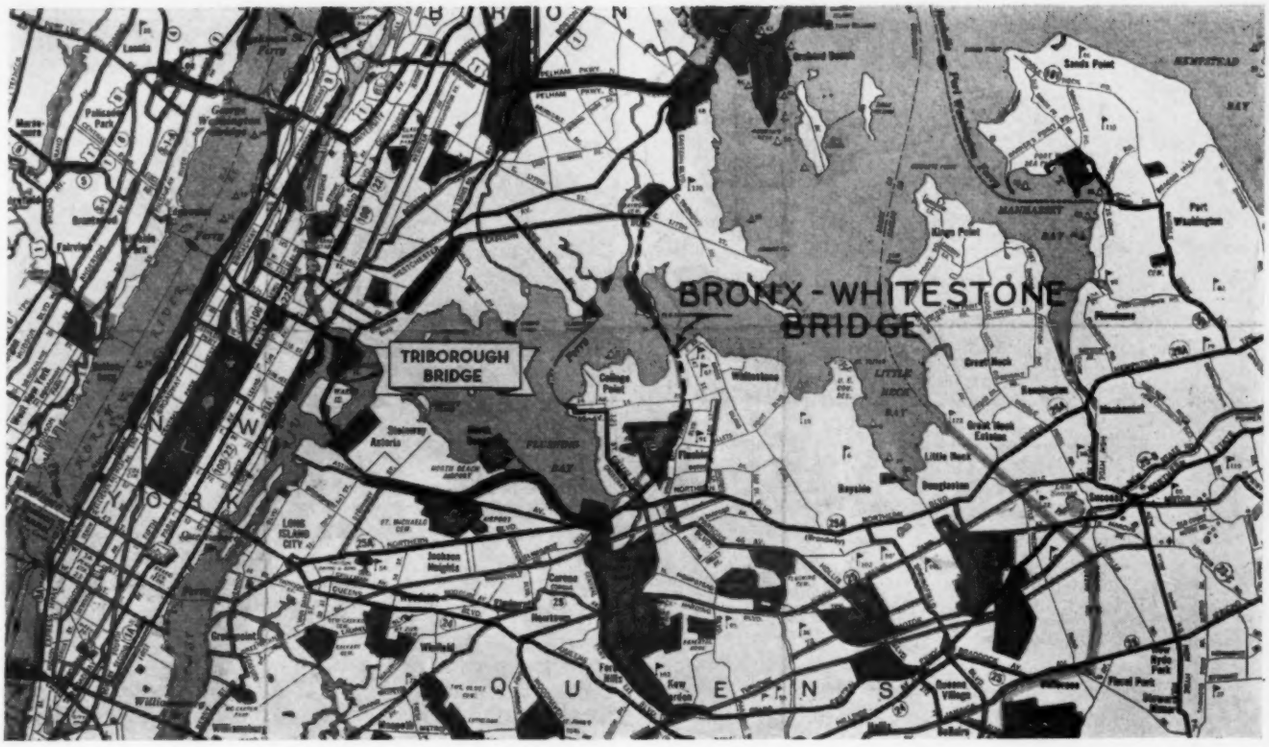
Before starting work each contractor is required to submit a detailed program chart together with a statement as to procedure and equipment to be used. This chart is then checked weekly against actual field progress and any unfavorable deviation is immediately noted and steps taken to rectify the condition. In this way, all contracts are continually under personal supervision of the Engineer of Construction and his assistants in charge of each particular contract.

The first step in construction was the contract for supplementary borings at the site of the bridge, awarded in May, 1937. In close succession followed contracts for foundations, tower piers and anchorages. Demolition of existing buildings on the approaches, grading and drainage on the approaches and grade crossing elimination contracts followed during the Summer and Fall of 1937. The largest single contract was awarded in October, 1937, for the construction of the East River suspension bridge. Contracts for paving and lighting have been awarded this year, and there now remains a portion of the paving, landscaping and miscellaneous work to be advertised.



Bronx Tower, Anchorage, and Approach Piers

Bronx Approach Piers. Note Arch Centering and Formwork Is Steel

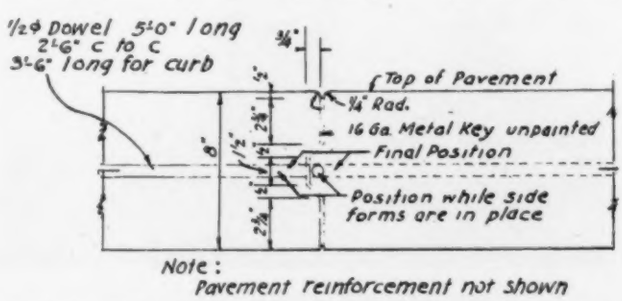


Map Showing Location of Bronx-Whitestone Bridge. Note the New York World's Fair Site at the Southern End of the Project.

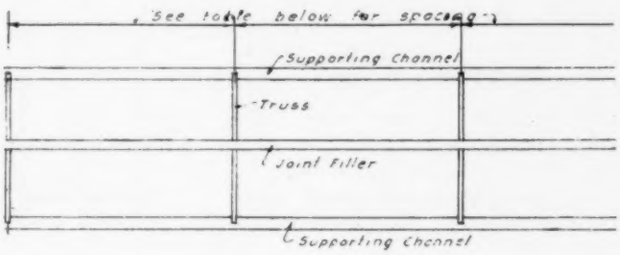
Details of Construction

Bronx Approach.—The intersection at Eastern Boulevard at the entrance to the Bronx-Whitestone parkway in the Bronx has been designed as a large traffic circle with ample distance for cars to choose their route. It is expected that New York State will, in the near future, eliminate this circle by the construction of three bridges and connect the parkway with other traffic arteries to the north by means of a new parkway. Design and land acquisition for this project are now in progress.

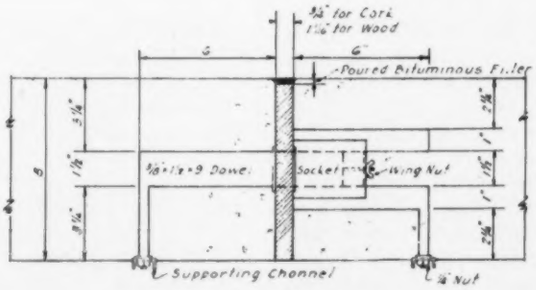
From Eastern Boulevard to the bridge, the project consists of twenty foot service roads on each side for local traffic and two separated 28 ft. wide parkways for through traffic. For a distance of 3,000 ft. from Eastern Boulevard cut and fill balanced. From this point to the approach ramp the route went over marsh land which had approximately a 15 ft. layer of sand. About 600,000 cu. yds. of material were placed in this area, the material being taken from a hill in the park area, which provided an opportunity for properly grading the park and obtaining an economical fill. In order to obtain a solid foundation for the parkway through this marsh area, a dyke of good material was constructed on the outer edge of the parkway forcing the mud out



Showing How Slabs Were Tied Together Longitudinally



PLAN



SECTION B - B

DETAILS OF PREFORMED EXPANSION JOINT AND SUPPORT

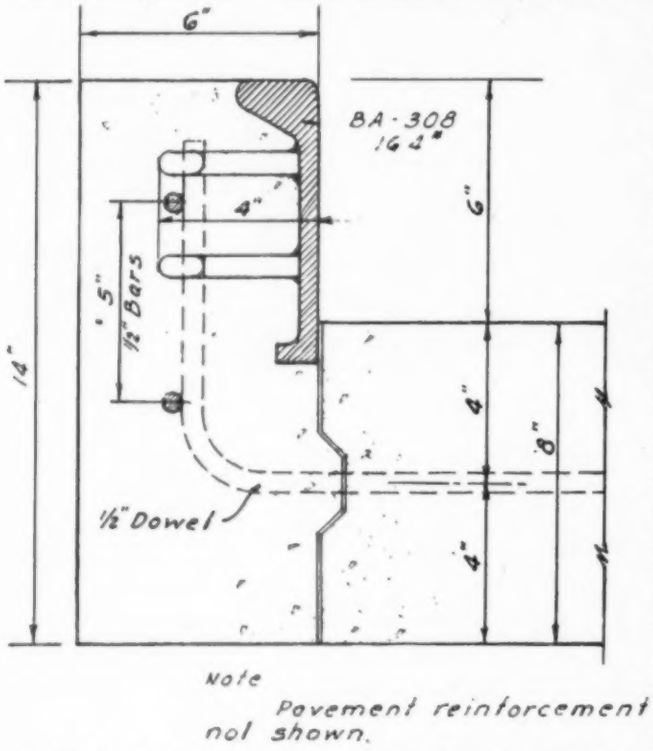
SPACING FOR TRUSSES

Slab Width	Spacing
9'-0"	5 spaces @ 19" and 6 9/16" from side
9'-6"	5 spaces @ 20" and 6 1/16" from side
10'-0"	5 spaces @ 20" and 9 1/16" from side
12'-0"	7 spaces @ 18" and 8 1/16" from side

Transverse Expansion Joint

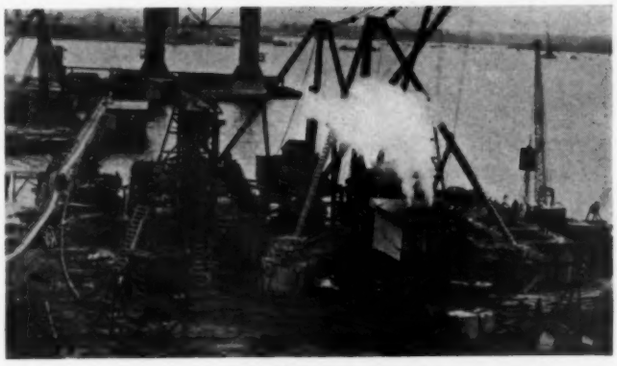
and trapping some of the mud towards firmer ground on the inner side in the park area. In order to reach the dyke the contractor built other dykes through the marsh area for use as construction roads. These additional dykes further divided and trapped the mud which was blanketed over with an average of eight feet of fill to form a compacted and stable surface for park use.

The parkway and service roads are being constructed of reinforced concrete eight inches thick with reinforced concrete curbs. At points of exit and access the curbs are further protected with a steel bulb angle facing. This feature is comparatively new, having been used recently in New York City in place of granite as it has been found to be more economical and of equal



Bulb Angle Curb Armoring. Dowel Ties Curb to Pavement Slab

wearing qualities. Another construction feature of the pavement is the tying together longitudinally of the concrete slabs and curbs so that longitudinal settlement and pulling apart at joints is eliminated. This is particularly important on this project as a considerable percentage of the entire pavement is placed on fill over marsh lands. All pavement on fill is reinforced top and bottom. A new type of transverse expansion joint is being used, consisting of a small structural steel truss which supports both slabs equally while allowing full expansion and contraction of the concrete. Six of these trusses are used in a ten foot wide slab, the joint for the full width of the slab being assembled as a unit and placed in position on the subgrade, thus assuring perfect alignment. The beam of the truss passes through a wood expansion joint filler one inch thick and the beam supports are bolted to continuous channels running the entire width of the slab. One end of the beam is encased in a close fitting metal sleeve which provides for expansion and the supports insure correct position. The assembled joint is easy for the contractor to handle and insures perfect support for the slabs. All joints are sealed with hot bituminous material but due to the use of wood between the slabs, there is no extrusion of material.



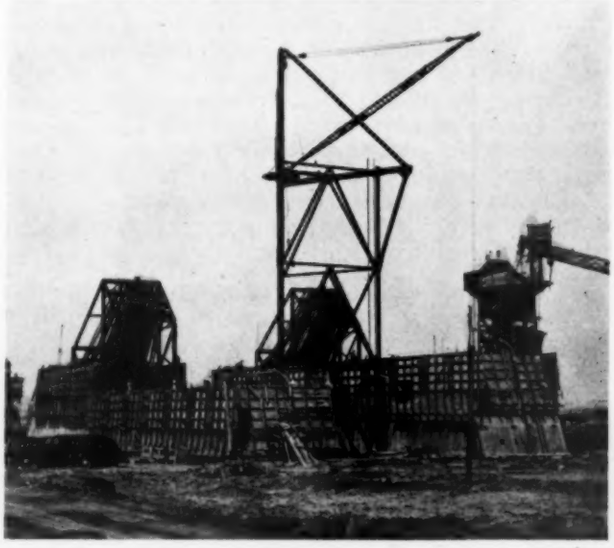
Looking North Across East River. Queens Anchorage in Foreground, Towers in Middle and Background, Showing Steel Bases on Queens Tower

The three lanes in each direction on the highway widen to six lanes in each direction at the toll plaza. Each lane is served by a toll booth, and an administration building will house the operating personnel. The islands at the booths are protected with a steel curb.

To the west of the parkway is Old Ferry Point Park, acquired by New York City at the same time the land for the parkway was bought. Part of the park is on high ground and part of it was salt marsh. A large part of the marsh has been reclaimed as a part of the filling operation described above. The park will be developed in part by the Authority and in part by the Park Department of New York City. Access to the park is provided from the parkway without the necessity of passing through the toll area.

Bronx End Ramp and Approach Span.—The concrete end ramp which is supported on a pile foundation is of hollow construction with concrete side walls. The ramp is 69 ft. wide, 266 ft. long, and is constructed on a 4 per cent grade, the end of the ramp being elevation 30. A construction feature provides manholes in the roadway slab through which sand and other materials are discharged directly into elevated storage bins in the garage below. Trucks in the garage may then be loaded from hoppers in the bins. The roadways are 27 ft. 6 in. wide separated by an island 3 ft. 8 in. wide and one sidewalk is provided for pedestrians.

The eighteen approach piers, consisting of two con-



Bronx Anchorage Under Construction

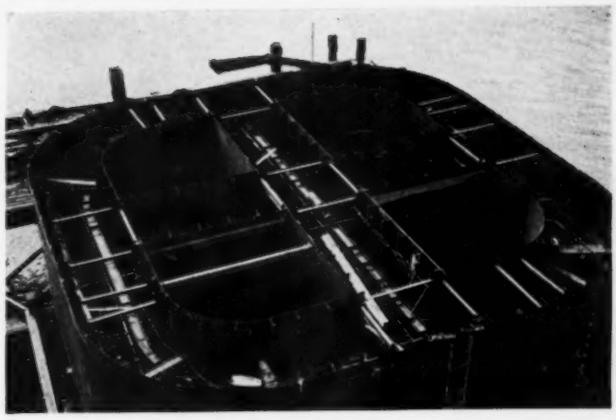
crete shafts and an arch cap, are supported on spread footings on sand. Cofferdam construction for the excavation was necessary on more than one-half of the piers to reach solid bearing. The piers vary in height from 50 to 120 ft. above the footings, and are constructed of reinforced concrete.

The Bronx anchorage is 110 ft. wide by 180 ft. long and is 115 ft. high. The anchorage is entirely of concrete with a hollow center, the sides being treated architecturally to accentuate the appearance of resisting the pull of the supension cables. The anchorage is supported on a spread footing, the northerly end being at elevation minus 10 and the southerly end at elevation minus 15.

The contract for constructing both the Bronx and Queens anchorages above the foundations was awarded as one contract. The Bronx anchorage is now completed and work has begun on the Queens anchorage.

To construct the Bronz anchorage the contractor poured the entire anchorage in 43 blocks, working two shifts part of the time. To visualize the different pours and to be sure that each pour was correctly set up, the contractor made a model of the anchorage which was cut into the 43 sections to be poured.

The Bronx tower is constructed on two concrete caissons 81 ft. center to center. The bottom of the east caisson is 92.5 ft. below mean high water and the west 96.5 ft. below mean high water. To construct these caissons a peninsular fill was placed out from the shore into the East River. Steel cutting edges were placed in the correct position on the fill and reinforced concrete side walls were constructed above the steel cutting edges. As sinking progressed the side walls were concreated in lifts of 10 ft. The interior of the caisson was divided into four compartments by concrete cross walls. Excavation was made with land equipment working from the fill previously placed, using 1¼ yd. clam shell buckets to excavate the interior of each compartment. Upon reaching rock, the compartments were pumped out and a concrete seal, 31 ft. in depth, was poured in a continuous operation.



Steel Shell of Queens Tower Caisson. Pre-fabricated and Floated into Place

After the seal was placed, the remainder of the shafts were allowed to remain filled with water. The tops of the caissons were then capped and connected with reinforced concrete struts and anchor bolts were set for the towers.

Steel erection on the tower followed immediately and has been completed. The contract for the erection of both towers was awarded as one contract for approximately 6,800 tons of steel. The tower is 348 ft. high and consists of two columns connected below the level of the roadway and at the top of the tower by arched cellular bracing. A single tower of 3,400 tons was erected in three weeks.

Bronx Tower with Anchorage in Background

Main Span.—The contract for the main span is the largest single contract of this project. Work to date has been confined to mills and fabrication shops where the structural steel is being rolled and wire for the main cables is being drawn.

The bridge provides for two separated roadways and one sidewalk. Two cables each 21¾ in. in diameter support the deck by means of wire suspender ropes. The quantities involved in the main and side spans give an idea of the size of the bridge. 15,000 miles of wire is being used in the cables which amounts to 4,000 tons and which is 5,000 miles more wire than was used for the Triborough Bridge. Over 12,000 tons of steel are being used in the deck. A complete lighting system with navigation and aviation lights will be installed.

The Queens tower is unusual, due to the great depth of the footings and its location which made necessary the use of floating equipment. Both caissons are sunk to rock at elevations previously noted. The tower is almost 1,000 ft. beyond the shore line and, as it was impracticable to fill out from the shore to that distance, the caissons, constructed with the steel cutting edge topped by a hollow steel shell, were floated into place and sunk to their final depth by the addition of concrete to the shell as well as by excavation inside. The same procedure of sinking was followed as was used on the Bronx tower. The caissons were filled with concrete to 31 ft. above the rock foundation and capped

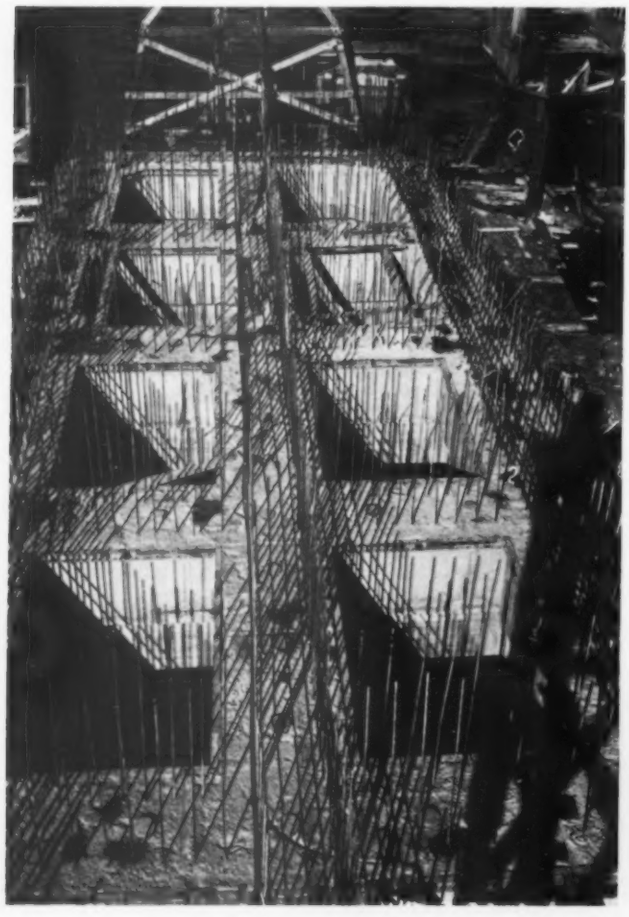
as on the Bronx tower. Steel erection was completed on about June 15, 1938.

The footings of the Queens anchorage are deeper than any others. For this anchorage four caissons were constructed on fill placed channelward from the adjacent shore. The two front caissons are 33 ft. by 100 ft. and the two rear are 24 ft. in diameter. All four caissons will be sunk to bedrock which is approximately 163 ft. below mean high water. The front caissons are divided into 10 compartments, the four front cells of which will be filled with concrete to 40 ft. above the cutting edges and the six rear cells will be completely filled. The two rear circular caissons will be filled to a depth of 40 ft. above the cutting edges with concrete. Quantities involved for all caisson work on both sides of the river include the following: 2,500 tons of steel, 73,000 cu. yds. of caisson excavation and 75,000 cu. yds. of concrete.

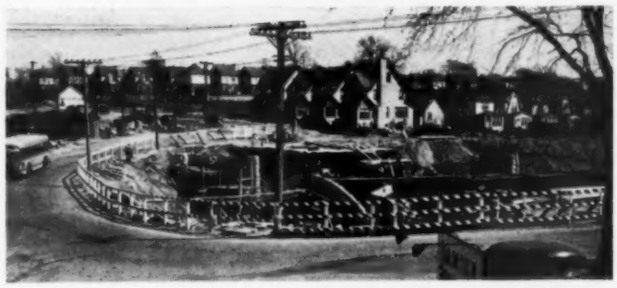
The Queens anchorage is being constructed by methods similar to those used on the Bronx anchorage.

The Queens approach viaduct is of the same construction as the Bronx with footings carried to solid bearing. On the Queens side, however, mud is not encountered. The concrete ramp is similar to the Bronx ramp. The contract for approach piers and end ramps for both the Bronx and Queens was awarded as one contract, involving 12,250 cu. yds. of concrete and 1,300,000 lb. of reinforcing steel.

Queens Approach.—From the ramp at the end of the bridge proper, parkway is constructed on grade for a distance of two miles to Flushing River. The project is again divided into service roads 30 ft. wide for local and truck traffic and two separate parkways 24 ft. wide



Caisson for Queens Anchorage



Grade Elimination at 14th Avenue Under Construction

for through passenger traffic. The width of right-of-way varies but averages 400 ft. For the first 3,000 ft. the parkway is in cut, which provided half of the million and a half cubic yards of fill necessary in the marsh lands. The remainder is being constructed through marsh lands and adjacent areas will be reclaimed for park usage by the city of New York. This entire grading job, including drainage, was awarded as one contract. The method of filling used on this approach differed from the Bronx in that no dykes were constructed. The marsh was blanketed with successive layers of fill which compacted the mud between the new fill and the underlying sand without disturbing the stability of the material. All roadways will be limited to one way traffic with existing grade crossings eliminated for through parkway traffic. The type of pavement construction is similar to that on the Bronx side with single reinforcement in areas of cut and double reinforcement in areas of fill, all slabs and curbs being tied together by dowelled longitudinal joints. Transverse expansion joint details and steel curb details are the same as on the Bronx approach. The paving contractor intends to use a new 37-E dual drum paver for the concrete pavement. The first paving contract covers about two-thirds of the Queens paving and includes 100,000 sq. yds. of concrete pavement with concrete and steel faced curb.

Grade Eliminations.—The grade elimination at 14th Avenue is a reinforced concrete, stone faced eliptical arch. The bridge at 20th Avenue is a flat beam and girder structure trimmed with stone masonry. The bridge at Linden Street is a reinforced concrete flat arch supported on piles and with abutments tied and braced below the street by concrete struts and a concrete slab. Fifty feet of mud was penetrated by the piles and the struts and mat were added to provide stability. As all three streets are heavily traveled, it was necessary to bypass traffic while construction was in progress.

Flushing River Bridge.—Flushing River is crossed by a double leaf bascule bridge. Between bulkhead lines the distance is approximately 280 ft. and the span between the center lines of the bascule piers is 174 ft. The vertical clearance at high water in the closed posi-

Grade Elimination at 14th Avenue Completed and Opened

tion is 35 ft., which allows all but large boats to pass through.

The structure consists of a concrete end ramp on piles, six piers on piles, two bascule piers one of which was carried to solid bearing and the other on piles, nineteen piers on piles and a concrete abutment on piles. Excavation on the bascule piers was done by cofferdam construction. Steel sheet piling was used on the approach piers. Supporting piles were carried through

Looking North Across Flushing River. North Bascule Pier Cofferdam in Foreground

40 ft. of mud to solid bearing. The construction was divided into two contracts—one for the foundations and the other for the superstructure.

The southerly terminus of the project immediately beyond the Flushing River is at Northern Boulevard which runs at right angles to the Bronx-Whitestone parkway. To provide access to Northern Boulevard as well as to the New York World's Fair directly opposite, the elongated traffic circle previously mentioned has been designed to permit one way traffic to proceed in any possible direction. Pavement in this area will be bituminous macadam penetration method on a broken stone base with a 1 in. wearing surface laid cold over the 3 in. penetration course. A separate contract will be awarded for paving this area.

In 1939, two years after the beginning of construction, this newest traffic artery of New York City will be opened for use by the traveling public. New parks for New York City will be opened, reclaimed from marsh lands older than the city. Millions of people and cars will pass over a bridge which for years has been a dream but which is now approaching reality.

Southerly Terminus at Northern Boulevard

Those Responsible.—An outline of the responsible personnel is as follows:

Triborough Bridge Authority—
Robert Moses, Chairman
George V. McLaughlin, Vice Chairman
Roderick Stephens, Vice Chairman
Colonel Paul Loeser, Director and Secretary.

O. H. Ammann, Chief Engineer
Allston Dana, Designing Engineer
Aymar Embury, II, Consulting Architect

Madigan-Hyland, Consulting Engineers
E. H. Praeger, Chief Engineer
Colonel H. W. Hudson, Engineer of Construction

Moran, Proctor and Freeman
Consultants on Foundations

Waddell and Hardesty
Consultants on Flushing River Bridge

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Anticipating Spring Wetness

On a chilly day last November, the field editor of ROADS AND STREETS overtook the outfit here shown at work tightening up bituminous joint and crack seals in Waupaca County, Wisconsin. The blow torch, supplied with air from a compressor on the truck, is pushed steadily along the bituminous strip, the flame playing directly on a small metal shoe, and then shooting out ahead as shown in the picture.

The bitumen melted instantly under the shoe, and so far as the editor could see in the course of twenty minutes' observation, completely closed all holes or cracks through which water might have penetrated. Because of the short period of heat application, the melting effect

Refinishing Crack Seals on a Wisconsin Highway

is confined to the material near the surface. A can of liquid asphalt was carried on the truck for use where additional filling material was needed, but the operator stated that he seldom required it. The torch was a Littleford Brothers product.

As this is the first season in which Waupaca County has done work of this character, its effectiveness cannot be determined until some time after the Spring thaw. We hope to be able to present a more detailed account after the results are known.

THE BRIDGE AS A PROBLEM IN HIGHWAY LOCATION

By R. B. YULE

Engineer of Bridge Investigations Indiana State Highway Commission, Indianapolis, Ind.

CURRENT engineering literature and text books contain interesting and instructive information about highway location problems but little is available, except in a general way, concerning the part which the bridge plays in arriving at proper alignment, both horizontal and vertical.

Road Project May Be Costly Bridge Project

It has been the bridge engineer's boast that he can design and build a bridge for any reasonable road alignment. It does not necessarily follow that the bridge should then be relegated to a minor role in determining highway location or that unnecessarily costly bridges should be built because other considerations fix the alignment before the bridges receive sufficient attention.

Most state highway organizations separate road and bridge design but do not have specially trained bridge survey parties to follow up the road survey, obtaining the particular information necessary at each site to build a bridge with the proper length and height to pass floods, economically designed to be safe against scour and foundation movement and using the best suited and economical type of structure and arrangement of span lengths.

There is a tendency to arrive at construction budgets, merely lumping bridge costs and to judge a state's activity solely on the basis of miles of road constructed or resurfaced. The cost of a bridge cannot be adequately determined until bridge survey notes are available and can be studied with the result that a so-called road project may be really a bridge project with a very high cost per mile of new construction.

Road Alignment Adjusted for Bridges

While the motor highway has been with us for about 20 years, its effect on the establishment of new areas of high population concentration has been slight. Rather the effect has been an extension of those areas which had their beginning in the railroad era. Consequently highway location has been largely a matter of connecting fixed centers of population rather close together and with the points of beginning and ending already established, the deviation from the shortest route could not be very great. Add to this the necessity for following existing rights of way or paralleling a railroad right of way and it is readily seen that the permissible variation in alignment to obtain good bridge sites is not great, but increases with the size of the stream or the cost of a grade separation.

In practice a suitable road alignment is determined by reconnaisance and lateral changes are made when a particularly bad bridge site results or a particularly good site is nearby. The saving in bridge cost must be balanced against additional road cost, additional driving distance, any increase in curvature or steeper gradients.

The May issue of ROADS AND STREETS carried a timely paper by Mitchell Hall of the Missouri State Highway Department, calling attention to modern practices in highway location surveys. Reference should be made to that article for minimum standards for the various classes of roads and a general discussion of road location.

Elements of Cost

Valley fill between high water lines and approach

Fig. 1—Wabash R. R. Bridge Over Helms Creek

Fig. 2—Bridge on Road No. 24 Over Helms Creek

Fig. 3—Bridge Over Otter Creek

grading for a grade separation are so much a part of a bridge project that they must be considered with it and the subject of this discussion could be better stated as the stream crossing or grade separation as a problem in highway location.

The cost of valley fill or approach grading is controlled by the cross section, the depth and the length of cut or fill. The grading sections are not affected by location except as they may change with varying depths of cut and fill or class of subsoil involved. The depth and length of cut or fill are directly affected by location and must always enter into the problem of determining an economical bridge location. The cost of the bridge structure itself is principally determined by the required strength, width, length, skew, height and foundation material. Ordinarily strength and width depend on the expected traffic on the road and are not affected by the immediate location except as a structure may be widened over the standard for the road on a horizontal curve.

In general, then, height and length of cut or fill in the bridge approaches and length, skew, height and foundation material in each structure should be considered together with all other factors when deciding upon a road location. Of course there are special problems such as those made necessary by the requirement to meet or avoid fixed points in plan or elevation.

Valley Fill

A minimum length of fill for a stream crossing would ordinarily be obtained when the valley is crossed at right angles at some convenient narrow point. It is necessary to examine a wide valley closely for some distance in the vicinity of a proposed crossing to ascertain if a narrow section exists which can be reached and crossed within the limitations for lateral deviation and maximum gradient. Contour maps such as the USGS quadrangle maps and the War Department river charts are particularly useful for this study as are also aerial photographs. The valley should also be examined for lateral ridges or rounded swells as they make a firm foundation and decrease fill height. The narrow valley or pronounced swell is not all clear gain as a constriction in the flow area results and the high water gradient shows a flat spot indicating an increase in high water rise at the point.

When the general direction of the road is not at right angles to the valley, a compromise between the short right angle route and a skew route must be considered. As previously mentioned, the answer usually lies in balancing less first cost against additional travel distance and curvature.

Waterway Area

Assuming that the proposed road is to be built above high water, the primary function of the bridge is to carry the roadway safely over the stream in flood. A discussion of design for the maximum flood to be expected as against, say, the 25-year flood or the determination of the required waterway area for the given flood, whatever it may be, is not in order here. However, the required waterway area is important because the minimum length of bridge is solely dependent upon the required waterway area and with a fixed area, skew has a major effect on cost.

If the required waterway area must be placed in more than one bridge because of well defined overflow channels or a wide valley, judgment can be used in placing the alignment for efficient overflow structures. Length, skew, height and foundation conditions affect their cost as well as the main bridge. Waterway area in general costs more per square foot in two bridges than in one because for the same total length, two abutments replace one pier. Overbank area near the main stream is not always as efficient as in an overflow channel because of lower velocity and the area supplied per foot of length may be much less near the main stream than at an overflow site as the immediate bank tends to build up with silt deposits and is generally higher than points where overflow channels are apparent.

Any feature of location that may require a greater length of bridge than that necessary to supply the required waterway area, adds to the bridge cost and should be offset by a saving somewhere else. Examples are slightly separated channels that could be crossed where close together or joined, an obstruction to flow outside the right of way but along side the bridge such as a building or a praallel stream and railroad to be

Fig. 4—Bridge Over Walnut Creek

crossed by a continuous structure but the distance between stream and railroad greater than the overbank distance required for flood flow.

Skew

Skew has a double effect in increasing bridge cost. All skewed foundations increase in cost about as the secant of the skew angle and the bridge must be lengthened so that the total span length equals that length required for a square crossing multiplied by the secant of the skew angle. Obviously when a rectangle is changed to a parallelogram by moving the top side ahead but keeping the perpendicular distance between the top and bottom sides constant, the ends, representing the bridge abutments, lengthen and the perpendicular distance between the ends, representing the effective span for the passage of flood water, shortens.

A single span square bridge can be set across a skewed channel with diagonally opposite corners clearing the required floodway section, in which case, the increased cost is that of a greater span length and heavier foundations to carry the greater span length. Square piers or bents in a skewed channel lead to excessive turbulence, decreased flow efficiency and scour.

After it has become evident that a skew crossing is necessary, an effort should be made to get as favorable a location as possible. Most bridge departments have standard plans for certain skews such as 15, 30 and 45 degrees in certain types of structures and pony trusses are most easily skewed one panel, giving an angle dependent on the panel length, and the distance center to center of trusses. It may be possible to cross the stream at exactly one of these angles.

Height

Since the effective waterway area is bounded by the bridge abutments, the ground line and the high water line, the importance of accurate high water information in determining span length is evident. Of equal or greater importance is the freeboard above the high water line established for the roadway embankments and the clearance for the bridge superstructure. These clearances are again dependent on what flood volume, as reflected in flood height, the crossing is being designed for and when established also fix the minimum height for the roadway embankments and bridge floor.

The ideal location would permit these minimums to be used and when additional height increases costs to an excessive figure, a search for a better crossing should be made.

Subsoil

A rule for determining economic span lengths has been stated to be that the cost of the substructure should equal the cost of the superstructure. In other words, half or more of the cost of a bridge may be expended below the ground line. It therefor follows that a proposed bridge crossing should be made where subsoil conditions are favorable if such a place can be found and reached.

Solid Rock in the stream bed and banks results in shallow and small footings and is the most favorable condition possible. Hard clay will have a good bearing power and is generally resistant to scour. Coarse sand and gravel have fair bearing power but are not resistant to scour and deep footings, scour protection or foundation piling will be necessary. Soft, mushy clay or water sand are the least desirable as they have little bearing power, scour easily and even with foundation piling, longitudinal movement occurs from horizontal forces such as expansion and contraction of the superstructure and unbalanced pressure from approach fills.

Horizontal Curvature

Horizontal curvature at a bridge site should be avoided if practicable, as provision must be made in the design for both horizontal curvature and superelevation. Design details are greatly complicated and construction costs reflect these changes from the ordinary. Transverse tilting also requires a higher crown of roadway to give the lower side the same clearance above high water as a level structure. However, when the topography is such that suitable alignment cannot be obtained otherwise or if placing a short tangent between two sharp curves in the same direction would other-

Fig. 5—Old Bridge at Turkey Run State Park

wise be necessary, horizontal curvature may be a necessary evil. The final test of road location is useability and simplicity in design and construction should not be the major consideration.

The difficulties attendant upon horizontal curvature in short spans may be minimized by the use of the under-fill type of structure or a deck design with cantilever edges in which the horizontal curvature is taken up in a varying width of the cantilever. Short spans should carry a roadway width equal to the width between guard rails on the normal fill section in order to avoid the appearance of a bottle neck.

When laying out approach curves, the locating engineer should estimate the length of structure required and its approximate position. The PC or PT of the curve should then be held away from the end of the bridge at least the length of the spiral or banking transition and preferably not less than 300 ft. for roads designed to carry more than 750 vehicles per day. If bridge handrails or trusses are too close to the end of a curve, they appear to encroach on the roadway just as an approaching vehicle is about to straighten out into the tangent.

Vertical Curvature

Vertical curvature introduces complications into design and construction but is not particularly difficult to handle as long as the ordinarily horizontal straight lines in the superstructure can be kept parallel. Combination of skew, vertical curvature and horizontal curvature should be avoided if possible. It is a general practice to avoid concave vertical curves over structures on account of difficulty in obtaining a good appearance in a sag but convex curvature is desirable both from the standpoint of appearance and drainage where an otherwise horizontal gradient would be used. Underfill structures for short spans simplify the design and construction and if they can be anticipated, place no restriction on horizontal or vertical alignment except as to height.

Channel Stability

When crossing the large streams exhibiting a tendency toward bank erosion and a shifting channel, the location should be made at a section of what appears to be stable channel as witnessed by large trees along the bank and no bank erosion nearby. Quite often an otherwise shifting channel will stabilize itself along a low bluff and a bridge crossing can be made at point. On the other hand a bridge location should not be made along a bluff or hillside which shows evidence of a gradual movement toward the stream as enormous horizontal pressures may act on an abutment and in some cases the movement extends far down into the ground.

Fig. 6—New Bridge at Turkey Run State Park

If the eroding banks cannot be avoided, the bridge survey should include sufficient topographical data to design bank protection or channel stabilizing works.

Channel Changes

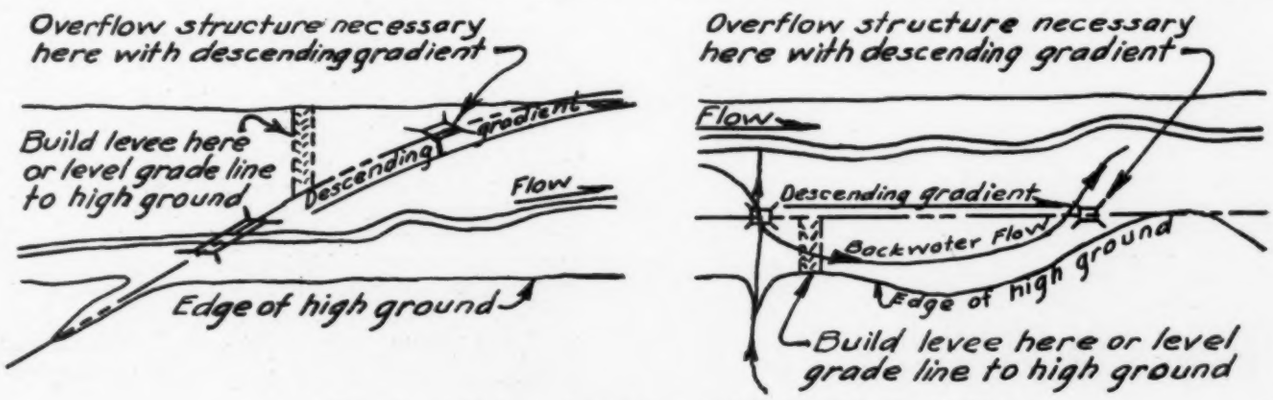
An unfavorable angle at a winding channel may be improved by a channel change. The new channel may be at an angle to the general direction of the valley and still be efficient as the channels of small streams control the direction of flow in their immediate vicinity. Channel changes can be anticipated and used to advantage in determining the horiontal alignment in tight places.

Shifting channels are the result of the stream attempting to find a gradient and horizontal alignment such that the channel may become stable. Since the factors determining velocity of flow vary with the depth of water in the channel, and the erosive action and carrying power vary as some function of the velocity, stability may never be attained.

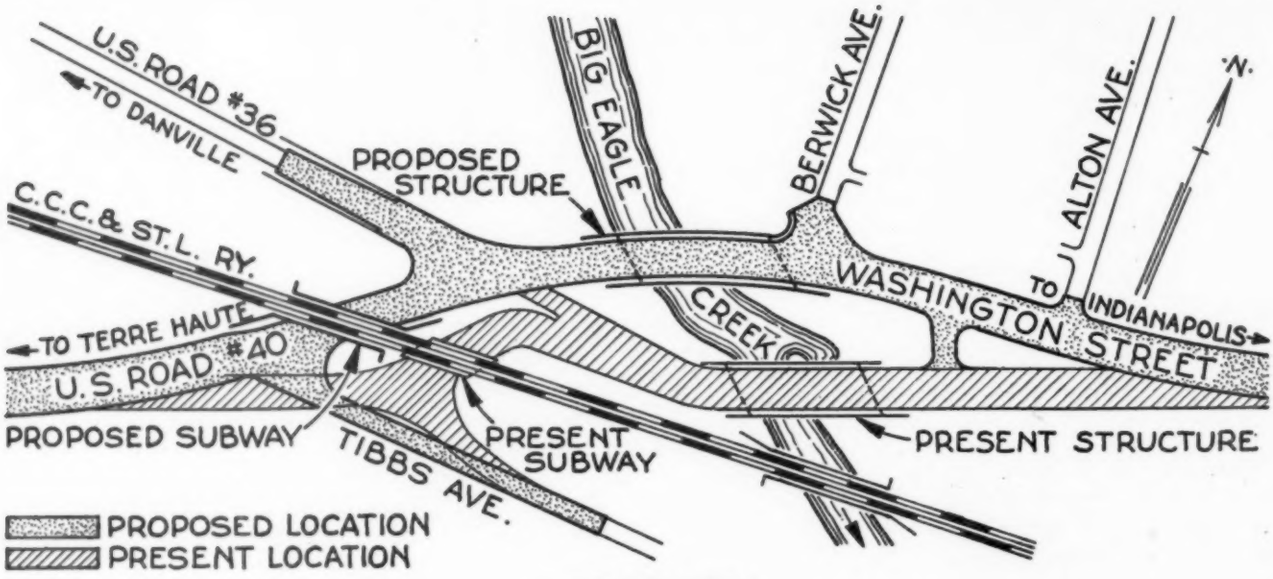
Ordinarily a channel change of a winding stream will shorten the distance which the water has to travel and leaves the difference in elevation at the beginning and end of the change the same. The result is a steepened gradient in a cleaner, straighter channel, increased velocity and increased erosive and carrying power. Therefore too much shortening of the channel in easily eroded soils should be avoided unless the economics of the case will permit lining the channel.

Special Problems

On long skew crossings of a wide valley, crossings from one side of the stream to the other when following a valley or when paralleling a stream in a valley, there is danger of laying the road grade line too low


Overflow structure necessary here with descending gradient
Build levee here or level grade line to high ground
Descending gradient
Flow
Edge of high ground
Overflow structure necessary here with descending gradient
Flow
Descending gradient
Backwater Flow
Edge of high ground
Build levee here or level grade line to high ground

Examples of Design to Prevent Overtopping of Road by Ponded Water



PROPOSED
·WEST·WASHINGTON·STREET·IMPROVEMENT·

An illustration of a Swing in Alignment and a Bridge on a Horizontal Curve to Overcome Obstacles in Both Plan and Elevation. The Skew Angle for a Straight Line Crossing Makes the Cost of a Structure to Carry a Double Track Railroad Over a Four Lane Street Excessive. In Addition, the Comparative Elevation of the Big Eagle Creek Bridge (as Fixed by the Necessity to Clear High Water) and the Railroad Rails Is Such That It Would Be Necessary to Drop 8 Ft. in 120 Ft. to Go Under the Railroad. This Location with Reference to the Railroad's Profile Is Such That a Track Raise Would Have to Extend a Long Distance in Both Directions and Would Involve Several Bridges and Existing Grade Crossings. The Proposed Alignment Will Cost About $300,000 to Build, About $200,000 Less Than a Straight Line Crossing, and Gives a Better Angle and Better Visibility for the Road No. 36 Intersection.

as the road proceeds downstream. In the first two cases, the pond elevation in the acute corners is determined by the high water elevation at the structure and unless overflow opening is provided in the downstream acute corner, the road gradient must be level rather than parallel to the high water gradient. In the third case, if the road grade line is dropped parallel to the high water gradient, water may flow outward from the main stream into a backwater area through a tributary stream bridge, ponding at the entrance elevation and overtopping the road lower down coming inward toward the main stream. The remedy is to build overflow opening, intersect nearby high ground or build a levee to high ground at some convenient place.

An unreasonably expensive bridge for a stream crossing in deep muck or peat may be avoided by changing the channel to firmer soil at the edge of the valley or to an island of firmer material either visible on the surface or discovered near the surface by soundings.

Whenever possible, side road intersections and important road junctions should be kept some distance away from a bridge. A bridge and stream have a tendency to distract a driver's attention and even the handrail of a deck type of structure is some obstruction to visibility. Y and ordinary road junctions should be studied for the possibility of increasing the number of lanes in the bridge and the survey made accordingly.

In rural areas or small towns, the location of a costly bridge should take into account whether local traffic warrants the maintenance of two bridges and if not the alignment and attendant road and street connections should be made in such a way that one bridge can serve all traffic.

Use of Existing Structures

A road survey following an existing road will raise questions in regard to the use of all or a part of an old structure that cannot always be answered by a casual inspection. The roadway width and condition are evident but an investigation of waterway adequacy and height to clear high water is always necessary. A strength analysis may also be required. A certain amount of traffic must be maintained and if other conditions permit, the alignment can be adjusted to leave an unsuitable structure far enough to one side to be used during the construction of the new road and bridge.

In case the abutments or both the superstructure and abutments are useable but too narrow, the center line should be laid over the proper distance to one side so that widening can be done on one side only, saving a pair of wings and a handrail and perhaps keeping the bridge open to two way traffic.

On highways built 15 and 20 years ago, there are many bridges with roadway widths now too narrow and located just off the end of a short and sharp curve or on a short tangent between two curves. A new alignment can be run placing the bridge site on a flat curve with about the same PI and passing through a predetermined point over a wide roadway and widening on one side only.

Under some conditions it is cheaper to relocate the road than to attempt to use a good old structure that does not fit either or both the required vertical or horizontal alignment. Experience has shown the advisability of using concrete arches, deck and under-fill structures whenever suitable because they can be raised or widened with less loss than a through type. It is not economical to build for some indefinite future width in rural areas as no one can safely predict the number or width of lanes that will be constructed nor how they will be placed with relation to the present center line. Predicted four lane widths are now being found

too narrow because of wider lanes and the trend to divided lane construction. Additional lanes are being added with right of way widening on one side only a primary factor in the location of the new lanes.

Grade Separations

Railroad grade separation locations have many of the cost and useability features of stream crossings and in addition the elements of wider right of way to accommodate deep cuts or high fills, objection to the fill as unsightly, the stress on eliminating a grade crossing or unsatisfactory grade separation with each project and the difficulty with connecting roads, streets, alleys and drives.

Vertical position is fixed by the existing rail elevations as in most instances the cost of raising or lowering tracks any appreciable amount is prohibitive. A common exception is the case where an otherwise good subway site cannot be drained by gravity unlesss the track is raised. Pumping is always a possibility but sure gravity drainage is preferable to pumping even though costing more on a capitalized cost basis. Occasionally raising or lowering the track will result in an operating advantage and the railroad should be given the opportunity to make a desirable change in the track profile.

The approach cuts and fills may be a large part of the cost of a separation and in urban or semiurban locations, the adjustment of existing streets, alleys and drives to the new grade line becomes a major problem. It is rare indeed that an original separation of grades on an existing street can be made without extensive cuts and fills. Obviously if a railroad cut can be reached for an overhead location or a fill pierced for a subway, the approach grading will be a minimum. Skew is a factor in the cost of the structure itself and often a swing in the alignment will decrease the skew and give a favorable location as regards grading at the same time.

Local conditions usually fix the choice between overhead and subway. Vertical clearance for a subway has been standardize at 14 ft. and with a superstructure depth of about 4 ft., the crown of roadway will be about 18 ft. below the rail. The drainage system must then clear at least 19 ft. and an outlet must be found not higher than this distance below the rail plus any necessary fall between. The proposed outlet of the drainage scheme must be above high water if the subway is to be kept clear of water. The railroads usually require 22 ft. vertical clearance and adding a superstructure depth of 3 ft. the crown of roadway will be about 25 ft. above the rail. Generally longer vertical curves are required over an overhead than in a subway to provide the minimum visibility. Consequently when the railroad is at or slightly above natural ground in level country, subway approaches will be much shorter than those of an overhead. Subways have the disadvantages of drainage troubles, drifting snow, cut maintenance and hydrostatic pressure on slabs and abutment concrete. Ice may not form so easily but is not so quickly reached by the sun. Multiple lane subways under multiple tracks on severe skews require very heavy superstructures to carry railroad loads. A division of the lanes will permit a center pier which is otherwise objectionable.

Examples of Bridge Location Problems

The accompanying illustrations are several examples of bridge location problems.

A survey was made to carry Road No. 24 into Wabash from the west following along the north side of the Wabash Railroad. Helms Creek was to be crossed adjacent to the railroad bridge shown in Fig. 1 and a high structure or one under a heavy fill would have been necessary. The alignment was changed about a quarter mile upstream giving as good an entrance to Wabash at no additional cost and a short, low structure as shown in Fig. 2. Helms Creek is cutting down to meet the Wabash River through limestone and this accounts for the great difference in height.

The Otter Creek crossing (Fig. 3) is contrasted with the Walnut Creek crossing (Fig. 4). U. S. No. 50 was carried over Otter Creek at about natural ground elevation, but U. S. No. 36 was brought down to just above high water elevation in Walnut Creek by taking advantage of opposing ravines descending from the surrounding high ground.

The old spandrel fill concrete arch (Fig. 5) spans Turkey Run (from which Turkey Run State Park gets its name) at a place where the overhanging rock almost closes over the little stream far below. When Road No. 47 was improved, the narrow gorge could not be crossed without a sharp swing in the alignment and reconstruction of a part of the developed portion of the park. The open spandrel arch (Fig. 6) is upstream from the gorge where the ravine is deep and wide.

Conclusion

It has been the purpose of this paper to call attention to the most common situations in which bridge problems should be studied before finally settling upon a road location and by inference to suggest the necessity for specially trained bridge survey personnel to follow up road surveys and to make surveys for bridge replacements on existing roads. Water, either above or below ground, is one of Nature's greatest blessings but also one of her greatest destructive forces and cannot be neglected or forgotten in designing roads for unbroken service over a long period of years.

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404,738,294 LBS. OF EXPLOSIVES SOLD IN 1937.—Final figures of the U. S. Bureau of Mines show that 404,738,294 lbs. of explosives were sold in 1937. The sales were made in the following fields:

	Black Blasting Powder			
	Granular Kegs of 25 Pounds Each	Pellet Cases of 25 Pounds Each	High Explosives Other Than Permissible Pounds	Permissible Explosives Pounds
Quantity used for—				
Coal mining.....	912,246	1,436,690	26,690,802	48,735,401
Metal mining.....	11,146	212	99,537,122	50,285
Quarrying and nonmetallic-mineral mining	80,688	15,537	52,776,585	433,750
Railway and other construction work.....	172,664	1,605	93,742,134	73,875
All other purposes...	16,722	2,114	16,177,610	286,130
Total, 1937	1,193,466	1,456,158	288,924,253	49,579,441

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PAN AMERICAN HIGHWAY CONFERENCE POSTPONED—The third Pan American Highway Conference, originally scheduled for September, 1938, has been postponed until January, 1939.

BASE STABILIZATION WITH EMULSIFIED ASPHALT

Experiences in District X of the California Highway Department

By C. F. BOVEY

District Maintenance Engineer, California Highway Department, Stockton, Calif.

FIVE emulsified asphalt stabilization projects were completed during the summers of 1935 to 1937 on two state highway routes, three projects being on Route 53 between Suisun and Lodi, and two projects on Route 75 just west of Stockton. All of these projects were in the delta or island regions where the underlying soil consists of peat, adobe, or heavy clay. Due to the close proximiity of the various rivers and marsh lands, the underlying soil was saturated with water during a considerable portion of the year.

The first project consisted of a 1-mile experimental section on Staten Island in San Joaquin County and was completed in August, 1935. An adjacent 3-mile section just across the Mokelumne River from Staten

View of Roadbed Immediately After Scarifying.

Island was stabilized in September and October of 1936. In 1936 and 1937 two sections totaling 4.3 miles in length were stabilized on Roberts Island just west of Stockton. In July, 1936, a fifth project 7 miles in length was so treated, between Suisun and Denverton. These five projects totaled 15.3 miles in length, were 18 ft. in width, and contained a total surface area of 162,000 sq. yds.

The Original Pavement

On all of the sections so treated, considerable difficulty had been encountered in the maintenance of an oiled surface. Conditions were quite similar on all of these sections. The original pavement consisted of a base of untreated crushed rock 4 in. to 6 in. in depth with a 2 in. bituminous macadam surface on four of the projects and a 2 in. cutback road mix on the other.

Scarified Material on the Right-Hand Side of the Road Windrowed Ready for Mixing. Material on Left Hand Side of the Road Still to Be Scarified and Windrowed.

The pavements were constructed over peat soil, and under heavy traffic the entire roadbed would vibrate. The adjacent lands were under irrigation, and due to inadequate drainage the roadbed was frequently flooded both winter and summer. Due to these adverse conditions the bituminous wearing surface and rock base failed to the point where reconstruction was absolutely required.

Applying Stabilization Emulsion to a Portion of the Aggregate Which Has Been Bladed Back Onto the Roadbed from the Windrow.

Mixing with a Mixing Machine. Windrow on the Left-Hand Side Has Already Been Mixed. Balance of Material Being Mixed and Deposited in the Second Windrow.

On some sections the original surface and base had been scarified and reinforced with standard untreated crushed rock for a compacted depth of from 2 in. to 3 in., the top 2 in. being road mixed with cutback asphalt. On one section the surface and base were scarified and salvaged and a 4 in. cushion of sand placed over the subgrade, after which the salvaged material was replaced and covered with a light wearing surface. All of these treatments failed, and further experiments were attempted.

In one case the cutback surface was scarified and reinforced with additional crushed rock and remixed with SC-2 asphaltic road oil. It was hoped that by fluxing the more brittle cutback asphalt with a lighter oil, a more resilient surface would be obtained which would not crack and check so readily under traffic.

On another section sufficient crushed rock was mixed with SC-2 road oil over the existing cutback surface to form a blanket of 1 in. compacted thickness. This resulted in a total mixed surface 3-in. in depth.

Mixing with Tracklaying Tractors and Pull Graders.

These two methods also proved unsuccessful, as the checking, cracking, and ravelling of the mixed surface still continued.

It became evident that the base must either be stabilized or heavily reinforced with additional rock. Previous experience on island peat soils had shown the danger of overloading such soil with fills or heavy pavements. A thickened pavement would also require rebuilding of shoulders to conform to the new height of pavement. The estimated cost of stabilizing with emulsified asphalt did not exceed that of reinforcing with 2 in. of crushed rock or gravel. As it would undoubtedly require from two to three times that amount of surfacing to obtain satisfactory results, the stabilization method was chosen as being more economical and as giving a better chance of success.

Methods Used in Stabilizing Treatment

Laboratory tests were made on representative samples of the material to be stabilized in order to determine the grading of the material. Emulsified asphalt stabilizer was used on the basis of 15 per cent by weight of the material passing the 200-mesh sieve. The amount of emulsion used on the various projects varied between a minimum of 3 per cent and a maximum of 4.8 percent.

Mixing with Patrol Grader.

On all but one of the projects, the mixing was done entirely with graders, disks, harrows, and cultivators. On one project a mixing machine was used on a portion of the work. This machine was not equipped to satisfactorily distribute the water and emulsion, and was therefore discarded, not however, before proving this method to be superior to blade mixing, provided proper control of the ingredients could be maintained. With the approved mixing machines now in use, this method is recommended.

The method of operation on all five projects was very similar. The base and surface were scarified to their full depth with 45 H.P. diesel tractors using graders equipped with scarifiers. The material was then thoroughly pulverized using the same equipment augmented by an orchard type disk, spring-tooth harrows and cultivators.

The material after being thoroughly pulverized was windrowed to one side of the road. When sufficient material had been prepared, one-third of the amount

was graded back onto one-half of the roadbed for treatment in ½ mile sections, allowing traffic to use the other half under pilot car control.

Water from a sprinkling truck was then applied to dampen the aggregate, after which an application of diluted emulsion was placed by means of a 2,000 gal. oil distributor at the rate of approximately one gallon per square yard. On some of our projects an orchard disk and spring-tooth harrow were then used to work the emulsion into the aggregate. Later, it was found

Mixing with Tractors and Pull Graders.

that a 15-tooth Dyer cultivator was far more effective for this purpose. The cultivator followed immediately after the distributor to work the emulsion into the aggregate and to keep it from flowing onto the roadbed. Two tractor drawn graders, or in some cases, two 45 H.P. diesel motor graders then followed with blades set at opposite angles, mixing and leaving the material in a windrow. The windrow was then flattened with a grader to approximately an 8 ft. width and another application of water and diluted emulsion was then placed and mixed in the same manner.

Spreading and Laying Out Mixed Material After Having Been Left in Windrow for Several Days to Dry Out.

Completion of the Laying Out of the Mixed Material.

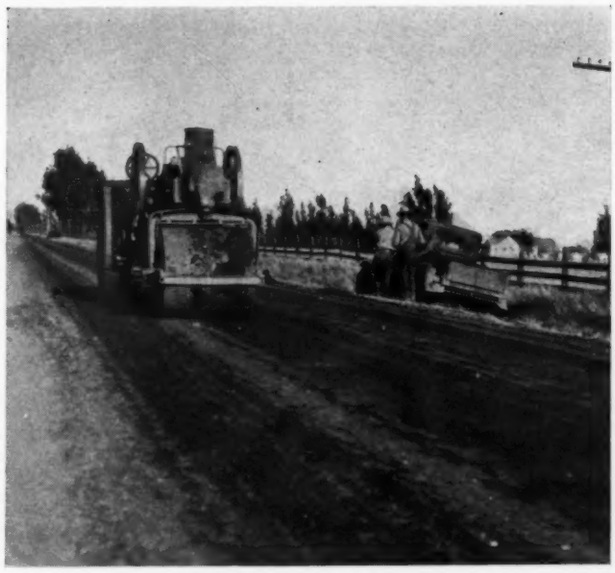
This process was continued until all the necessary water and emulsion had been applied and the material was thoroughly mixed, after which the windrow was bladed to one side and the remaining windrows so treated.

In diluting the emulsion in the distributor tank it was found necessary to add the water to the emulsion rather than in the reverse order, which caused curdling and formed slugs. On our various projects, in addition to diluting the emulsion in the distributor in the ratio

Spreading Mixed Material with a Power Grader.

of 1:1 it was necessary to apply additional water to the aggregate in order to obtain the proper consistency for mixing. On these projects the total amount of water used varied from 3½:1 to 6:1.

When emulsion is applied at the rate of 3 per cent by weight for a 6 in. depth of surface, approximately 2.3 gal. of emulsion or 4.6 gal. of diluted emulsion per square yard are required. Assuming the total amount of water used to be in the ratio of 5:1, a total of 13.8 gal. per square yard of water and emulsion would be required.



Rolling Stabilized Base.

With this amount of liquid being applied in the manner just described, it is rather difficult to keep the subgrade from becoming muddy and to find space for the several windrows of both treated and untreated material, and at the same time to keep one-half of the road dry and in satisfactory condition for traffic. With a properly designed mixing machine the procedure would be much simpler. Usually, a satisfactory mix can be obtained with less water than is required for road mixing. The water and emulsion are applied to the aggregate in the machine, and even though it be necessary to divide the material into several windrows, no particular difficulties are involved.

Stabilized Base After Completion of Rolling.

The completely mixed material in the windrows was left alongside the road for from two to four days to allow sufficient water to evaporate before placing and rolling. The mixture was then spread in three layers of approximately equal depth, each layer being rolled with a 10-ton 3-wheel roller. After thorough compaction the surface was lightly swept to expose the aggregate in order to obtain a satisfactory bond. It was then treated with either a light application of SC-1A asphaltic road oil or diluted stabilization type emulsion. Some bleeding occurred during the summer months where the SC-1A road oil was used, probably because it did not penetrate sufficiently into the stabilized base. It is felt that the prime coat of diluted emulsion has proven more satisfactory.

A light wearing surface was then placed, consisting of an application of ¼ gal. per square yard of quick-setting emulsion and 25 lb. per square yard of ¼ in. by ½ in. crushed rock screenings. This light wearing surface has proven quite effective over the stabilized base.

Closeup View of Texture of Stabilized Base Prior to Surface Treatment.

Results Obtained

In spite of the fact that the previous surface on all of these projects had failed badly, prior to the stabilization treatment, all of the projects, with the exception of one, have lived up to our expectations and have given

Applying Diluted Stabilization Type Emulsion to the Stabilized Base.

satisfactory service without the use of additional reinforcement.

Of the four projects, two show no base failures whatsoever, while the other two have developed only a few such failures. A small amount of patching has been required on the light wearing surface, due principally to a lack of bond between the wearing surface and the stabilized base. On the other section, that between

Applying ¼ Gal. Per Yard Application of Quick Setting Emulsion for Light Wearing Surface.

Suisun and Denverton, many base failures occurred during the winter and spring following construction. A survey revealed the failures to be confined to only three of the seven miles, with the actual failed portions comprising only 10 per cent of the entire area of the 7-mile section.

Samples taken from both the failed and sound portions of the pavement and of the subgrade thereunder were tested in the laboratory. Samples taken from the sound portions showed high stability, while those taken

Quick Setting Emulsion Applied to One-half the Roadbed; Screenings Being Applied Through Spreader Box.

Equipment Used for Brooming Screenings with Drag Broom Rolling in the Background.

from the failed sections were very low in stability. The material comprising the subgrade was classed as a very poor grade of heavy clay and adobe and thoroughly saturated with water. The laboratory report described it as a type which would normally require a blanket of selected borrow and pavement 18 in. in thickness to satisfactorily carry heavy traffic. In many of the failed sections the total thickness of base and surface was found to be only 4 in. to 5 in. The laboratory

Rolling Screenings with 3-Wheel Roller.

report stated the cause of failure was due partly to insufficient depth of treated base but primarily to an unstable subgrade.

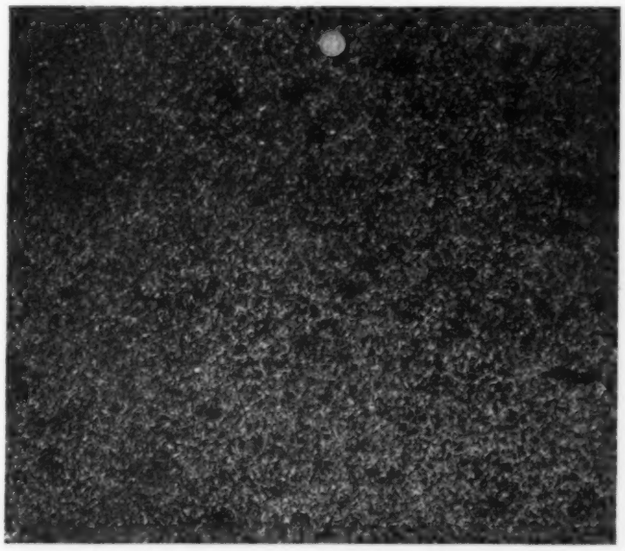
Oven dried specimens from the failed areas did not absorb any appreciable amount of moisture in the sand bath test, whereas undried specimens continued to absorb additional moisture. Before emulsified asphalt can become effective as a stabilizing agent, it is necessary that the treated material become dry enough for the

Completed Light Wearing Surface

force of adsorption to surround the individual soil grains with a thin film of asphalt. In this particular instance, it is felt that due to the highly saturated condition of the subsoil, portions of the treated base failed to dry sufficiently because of capillarity, to permit the asphalt to become effective. This may have been responsible for some of the failures. In spite of the all adverse conditions, 90 per cent of the treated base has carried through two wet winters without failure, while previous to such treatment extensive failures were general through out the entire area.

It is felt that the use of a sheepsfoot roller would have materially decreased the number of failures on this section. The use of this type of roller permits the placing of stabilized material while still in a wet condition, but the excess water is fairly well removed by the action of this type of roller. It is recommended that such a roller be used on all stabilization projects.

An additional blanket course was placed over the sections containing the greater portion of these failures.



Closeup View Showing Texture of Completed Light Wearing Surface.

Suitable gravel or crushed rock was not available at a reasonable cost. Tuff, from a nearby source, which had previously proven satisfactory, was used for this blanket. This material was placed over the surface of the stabilized base to a compacted depth of 6 in. One inch of SC-4 plant mix was then placed over the compacted tuff to form a wearing surface. Earth shoulders were brought to grade with local imported borrow. Total cost of this treatment was $6,700 per mile, $0.635 per square yard, or 1 ct. per square foot per inch of depth. To date this blanket type construction over the stabilized base has proven very satisfactory, inasmuch as no failures have developed during the past wet season.

On the five stabilization projects described herein, the total cost per mile ranged from $3,350 to $4,460 for an average per mile of $3,900, 37 ct. per square yard, or ¾ ct. per square foot per inch of depth.

Prior to the use of emulsified asphalt stabilization, our usual practice under similar conditions was to reinforce the base with clean crushed rock or gravel free from all soil or clay.

In 1935 and 1936, two portions of Route 53 were reconstructed at locations in close proximity to two of the stabilization projects on this same route. The existing surface consisted of the same type of construction as that which originally existed on the two stabilization projects. The existing surface was scarified and reinforced with untreated crushed gravel or stone surfacing for a 2 in. compacted depth. A wearing surface was placed, using the same type of construction as that used on the stabilization projects. The average cost of these two projects was $4,100 per mile—slightly higher than the average cost per mile for the stabilization treatment.

It is quite safe to say that under ordinary conditions the cost of stabilizing a surface already in place is practically equal to that of reinforcing with crushed rock or gravel for a depth of 2 in. For any required depth of reinforcement over 2 in., the stabilization treatment would be more economical.

Acknowledgment.—The foregoing is taken from a paper presented March 23 at the annual meeting of the California County Engineers' Association.

▼

$5,500,000 Toll Bridge at East St. Louis, Ill.

A grant of $2,475,000 has been made by the Public Works Administration to St. Clair County, Illinois, for the construction of a $5,500,000 interstate highway toll bridge across the Mississippi River, between Stites Township, adjacent to East St. Louis, Ill., and St. Louis, Mo. The remaining $3,025,000, will be furnished by St. Clair County through the sale of bonds to private purchasers. The bonds will be liquidated over a period of years, by toll charges for vehicular traffic using the bridge. The War Department has approved the bridge as planned. The length will be 8,063 ft., including the Illinois and Missouri approaches. It will be of steel superstructure, with concrete piers and deck. The roadway is to be 42 ft. wide, with sidewalks in addition. The Illinois approach will be at St. Clair Ave., while the Missouri approach will be on Broadway, between Florida and Mullanphy Sts., in St. Louis.

▼

ENGLAND'S FIRST AUTOSTRADA.—The Lancastershire County Council has approved for a 54 mile road, to cost about $25,000,000.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ They tell a good story on one of the manufacturers of road building equipment that occurred at the recent joint exhibit committee meeting luncheon of the American Road Builders' Association. It seems that one of the manufacturers, who we'll call Jim, just to give him a name, was talking with one of the engineers, whom we'll call Joe, so that he'll have a name, too.

Jim thought he'd have some fun with one of the waiters, so in ordering his coffee, he told the waiter that he wouldn't take it unless it was served in a left-handed tea cup. The waiter came back shortly and stated that he was sorry but he couldn't locate a left-handed tea cup. Jim then demanded to see the head waiter. From this dignitary, he requested to be served with a left-handed tea cup. The astute head waiter bowed and hurried out to the kitchen, returning with the cup of coffee.

Said Joe, "That's luck, they had one on hand."

• •

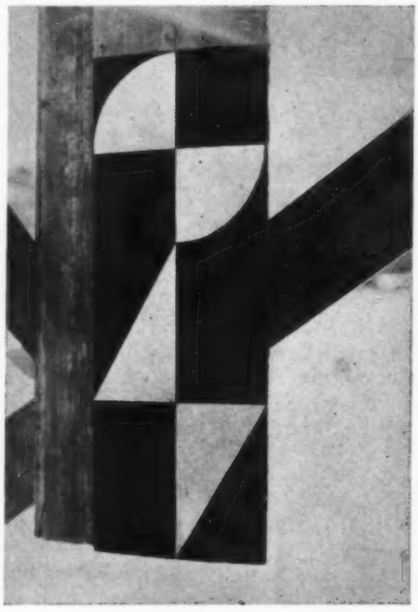
¶ The restaurant where Jim and Joe were dining was getting ready to redecorate. The manager told the painter to be a little different this time about the wash room designations. He told the painter to get away from the standard, "Men" and "Women" signs and do something different.

Next day the proprietor returned and saw a dog painted on each of the wash rooms. To the painter: "And what does that mean?"

Painter—"Well, sir, the one on the left is a pedigreed setter, and the one on the right is a pedigreed pointer. Everybody knows that."

• •

¶ On the Lexington-Purcell, Oklahoma, bridge, the engineers have erected the accompanying target as



a permanent foresight for placing the handrail.

• •

¶ The Minnesota highway patrol, in February, practiced "courtesy service," their motto, by pulling 380 cars out of the ditch. The guardians of the highways in Minnesota operate on a public-cooperation basis that is commendable and highly desirable.

• •

¶ By posting gravel and lower type surface roads at 4-ton limits during the "spring break-up" in Minnesota, not only do restricted stretches of highway save the taxpayer money by preserving road surfaces, but in the end they save time and money for highway users by shortening the period any stretch might have been closed in case a total breakdown made the highway impassable.

• •

¶ Acquisition of land for right-of-way in Minnesota by direct purchase has generally proved to be $30 an acre cheaper than acquisition by condemnation. This is a good point.

Think of the elimination of court expense and lost time, and the advantage of complete control when the direct purchase plan is used.

• •

¶ Missouri makes mighty good use of the broken concrete taken from pavement slabs repaired or removed to make way for a new slab. They use them as dry rubble in erosion control on back slopes and along creek banks where scour has started. In Kansas I note they make check dams out of the broken concrete.

• •

¶ If you want to see a good road travel over the Jefferson Memorial Highway just west of Hempstead, Texas. It is smooth, non-glaring, skid proof, and while a two lane road, the lanes widen to three over the crest of all hills. Traffic stripes clearly indicate safe zones. An excellect highway.

• •

¶ Columbia, Missouri, a thriving little city noted for its snappy colleges, might also be noted for its snappy traffic lights. There are five of them on Broadway, the principal business street, and their average time between changes is exactly 13 seconds. The change is simultaneous, but in opposite directions for adjacent lights; that is, when one light is set for Broadway, the light at the next block is set for the cross street, and so for all five. The timing seems well adapted to local conditions: at least I found it satisfactory in the course of several drives through. However, I understand that there is some (not much) complaint from pedestrians. Incidentally, the 13 seconds includes a "Traffic Change" period of 1½ or 2 seconds. At times it seemed that Broadway was kept open a trifle longer than the cross streets, but the difference, if any, was too small to be measured without a stop watch.

¶ Herewith a long shot view of the American unit of the new Thousand Islands International bridge. The Canadian structure has not progressed this far yet. Only the cables

were hung when I visited the job. The picture here shows a hoisting outfit near the foot of the nearest tower. This outfit is on the shore and handles the placing of structural steel on the center suspension span. Herewith is shown a close-up of the operator of the hoist. Note the telephone headset he wears with which to catch his instructions from the "pusher." Both

hand signals and telephoned instructions guide him. The structure is being erected by the American Bridge Co. The bridge crossings are expected to be ready by the first of August. Where are the 1000 Islands? At the eastern end of Lake Ontario. The bridges cross the two channels of the St. Lawrence River and part of the roadway between them crosses Wells Island.

• •

¶ As I passed through Fairview, Pa., on U. S. 20, I noticed a sidewalk grade changing job in which the old

sidewalk slabs were being lifted and moved a short distance to the new spot. The rig shown here was used to handle the squares of concrete. It worked excellently.

• •

¶ Herewith a couple of views of an interesting WPA brick resurfacing job on Market St. in Ft. Scott, Kansas. Why? Because the cushion is limestone chips carrying a small

clay content, and becomes hard when the brick are rolled. After 36 years of service from the brick in the old

pavement, they showed about 25 per cent gain when laid in the new surface.

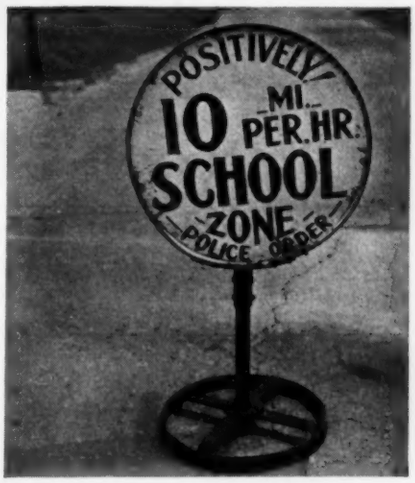
• •

¶ In driving over Route 66 in Illinois, I was impressed with the excellent manner in which business districts were avoided. The route through several towns was kept in the outskirts, while better still, some places were by-passed completely. It took a long time for local boosters to learn that through traffic brings more loss than profit; and even many traffic authorities were slow to realize that both traffic and local business suffer when brought together; but very definitely we are learning.

¶ As I recall, I believe the longest single stretch of smooth concrete road I've traveled is on U. S. 66 in Oklahoma, from Tulsa to Miami.

• •

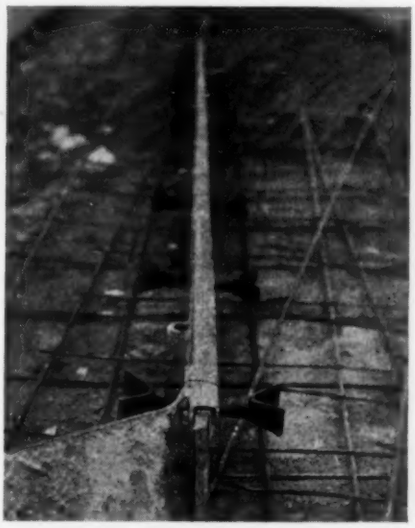
¶ Evidence of many signs like this aggravates through drivers, particularly when they stay in place all day long. Pretty soon these Iowa and



Oklahoma towns will be asking us to get out and push our cars through town. This sign was photographed at 11:00 a. m. in Miami, Oklahoma, on U. S. 66. No school or children were in sight.

• •

¶ On the Merritt Parkway (Connecticut) job of the New Haven Road Construction Company, cork expansion joints are used with these malleable iron joint dowels fixed



thereon. In the view herewith, a metal retainer is holding the cork joint ready to be inserted between the forms. During finishing the metal retainer is removed for use on the next joint.

INTERESTING AUTOMOTIVE DATE

On July 22, 1862, America's first truck was invented by Joseph R. Brown "of Minnesota" and built by John A. Reed of New York.

American Road

WASHINGTON, D. C.

ACCIDENT ANALYSIS PUBLISHED BY

Down the Road

By CHARLES M. UPHAM

Engineer-Director,
American Road Builders' Association, Washington, D. C.

SEEING IN THE DARK

When night falls, Death stalks the unlighted American highway. The night driver has from four to ten times as many accident-provoking hazards to contend with as the motorist who confines his use of the road to daytime travel. Steering a motor vehicle over a dark highway, despite the low volume of traffic on the road after the sun goes down, is as uncertain a process as a roll of the dice. It's an extremely dangerous game in which Life is always the stake and in which Death usually holds the winning cards.

Twenty-three thousand eight hundred or 60 per cent of the 39,700 persons killed in traffic accidents last year met Death on the highway after dark. The rapidity of modern streamlined transportation has catapulted the American highway user beyond the security he used to enjoy within the range of his headlights at a slower speed and in a less powerful vehicle. The headlights of the 1938 model motor vehicle are doing more than a good job when they penetrate as much as 200 feet of darkness. If you are driving at the rate of sixty miles an hour, your motor vehicle will cover those 200 feet in little under two seconds.

Not much chance in two seconds, in that limited range of visibility, to clearly define the obstacle aheads, to make up your mind what to do to avoid collision, to slam on the brakes, to swing your vehicle around and beyond the hazard, with Death chuckling up his sleeve at your frantic efforts. And, all too often, that's the end of you, except for the fact that you are next day added to a string of figures that last year totalled a disgraceful 23,800. All because you couldn't see in the dark!

Night traffic-accident fatalities have increased close to forty per cent since 1930. During that same period of time motor-vehicle deaths during daytime hours decreased three per cent. It has been determined that your chances of becoming involved in a fatal traffic accident at night are twice as great as they are during the day. It has been further determined that the cost of night accidents range from $2,000 to $8,000 a mile.

Well, you say, I'm interested, but what proof is there that highway lighting reduces the night traffic-accident fatality and serious injury rate? One of the most convincing answers to that question is the four-year study of the parkways of Westchester County, New York. With lights in full after-dark service, the ratio of day to night accidents was 1 to 2.2; with lighting reduced 40 per cent the ratio jumped to 1 to 3.7, and, with all lights turned off, the rate climbed to 1 to 4.8. Here's another good one. Recent figures obtained from the New York State Highway Department concerning Route 17-C, at Binghamton, show that highway illumination reduced night fatalities 67 per cent, entirely eliminated serious night injuries, dropped night pedestrian accidents 75 per cent and cut all night accidents in half. An outstanding example of another state's interest in lighting highways for safe night driving is New Jersey's recent illumination of White Horse Pike, running fifty-six miles across the state from Camden to Atlantic City.

BRITISH ASSOCIATION ANALYSES ACCIDENTS

An investigation conducted by the British Automobile Association into the cause of 854 traffic accidents reported by its patrols during the past year showed that 586 of these accidents were due to the human element and 125 to road defects, while 143 were classified as "acts of God."

ACCIDENT ANALYSIS PUBLISHED BY SAFE HIGHWAYS PROBLEM COMMITTEE

The report of the Problem Committee on Analysis of Accident Data of the Committee on Safe Highways of the American Road Builders' Association is a recent publication of the association. Copies of the report, known as Bulletin 52, can be obtained by writing the A.R.B.A. offices, 952 National Press Building, Washington, D. C. Under the chairmanship of Harold F. Hammond, director, traffic division, National Conservation Bureau, New York, the committee has collected data concerning accident-prone locations and the corrective measures applied to them.

UPHAM IS VISITED BY ARGENTINE ENGINEERS

Three young engineers from the Direccion Nacional de Vialidad of the Argentine Republic were recent visitors to Washington and the offices of Charles M. Upham, engineer-director of the A.R.B.A. Their names are Juan L. Carattino, Alberto Miguel Podesta and Andres Lastiri Ruiz and they plan to spend eight months in this country inspecting highway conditions and new road-building equipment. Mr. Carattino's specialty is soils and he will visit the highway departments of Missouri, South Carolina and Indiana. Mr. Podesta will pay particular attention to bituminous surfaces and base causes during his tour through Nebraska, California and Oregon, while Mr. Ruiz will study maintenance in Illinois, Iowa, California and Arizona.

CORNELL HOLDS ROAD SCHOOL

A four-day training school for highway superintendents was held last month at Cornell University. The Town and County Officers Training School of New York State, the State Association of Superintendents of Town Highways, the State College of Agriculture and the College of Engineering sponsored the school, it being the first of its kind in New York. Technical experts from both colleges, the United States Bureau of Public Roads and the state division of highways were on the program which was designed to help highway superintendents to solve their practical problems.

Builders' Review

JULY, 1938

RELYING ENTIRELY ON HIGHWAYS

There are about 8,000,000 people living in more than 45,000 communities that are without rail service and must rely entirely on the highways for transportation.

SAFE HIGHWAYS PROBLEM COMMITTEE

With Our State Groups

COLORADO

Colorado, according to James B. Kenney, secretary, Colorado Association of Highway Contractors, Denver, Colorado, is being flooded with a great number of unemployed who have been lured to Colorado by prospects of work on Colorado highways and on the Big Thompson transmountain diversion project.

CONNECTICUT

The state highway department of Connecticut has undertaken a far-reaching inventory of its highway system which is to include a financial survey and a traffic analysis. Traffic-accident fatalities and injuries in Connecticut have decreased materially during the first five months of this year.

GEORGIA

Word from Paul L. Andrews, executive secretary, Georgia Highway Contractors' Association, Atlanta, Georgia, states that skilled crews from the state division of highway planning are conducting traffic counts on all types of roads and are also mapping every county in the state.

NEW HAMPSHIRE

The recently convened New Hampshire Constitutional Convention witnessed the proposal of four constitutional amendments which will be submitted in the fall to the voters of New Hampshire for ratification or rejection. One of these provides a constitutional ban on any diversion of motor-vehicle transportation revenue to non-highway projects.

PENNSYLVANIA

The Pennsylvania Motor Federation has adopted a program which calls for definite opposition to all diversion, the repeal of the one-cent federal emergency gasoline tax, the elimination of Pennsylvania's temporary one-cent gasoline tax, opposition to the use of parking meters on city streets and the advocation of a rational and modern highway program.

TENNESSEE

George R. Dempster, engineer-manager of the Tennessee Road Builders' Association, an A.R.B.A. affiliate, was guest speaker at the April meeting of the Tennessee County Highway Officials' Association in Paris, Tennessee, which was attended by more than 200 delegates.

TWO MORE YEARS OF FEDERAL AID FOR HIGHWAYS

Congressman Wilburn Cartwright of Oklahoma, chairman of the House Roads Committee, who introduced legislation to continue federal aid for highways for 1940 and 1941 in the House of Representatives early this spring, watches Speaker of the House William B. Bankhead of Alabama sign the new Hayden-Cartwright Highway Bill after its passage by House and Senate. President Roosevelt signed the bill on June 8, making it a law.

TEXAS

A speakers bureau has been organized by the Texas Good Roads Association for the purpose of furnishing qualified speakers to various groups over the state that are interested in obtaining accurate factual information concerning the highway program and its needs and also the activities of the association.

U. S. HIGHWAY 59 BOOSTERS MEET

The U. S. Highway 59 Association of Minnesota and the Civic and Commerce Association of Detroit Lakes jointly sponsored a meeting of good roads advocates at the Edgewater Beach Hotel, Detroit Lakes, Minn., on June 13. Primary purpose of this meeting, which was preceded by a week-end of fishing, was the continuation of the fight for the ultimate completion of U. S. Highway 59 from Iowa to Canada with all-weather surfacing, built on U. S. standard grade construction throughout.

A STUDY OF MUD-JACKING OPERATIONS

By A. G. McKAIN
Assistant Resident Engineer
Texas State Highway Department

THE initial step in mud-jacking operations should be the selection of soil materials suitable for use. This involves careful preliminary study as a suitable material is fundamentally the basic factor towards satisfactory performance of the whole operation. Soils having an excess of sand result in packing both beneath the slab and in the pump. The absence of sufficient silt clay paste causes the sand particles to settle rapidly, leaving the minor portion of silt clay remaining in suspension. On the other hand, soils having a high clay content do not form a smooth paste readily, causing the pumps to jam.

Soils should be selected with respect to location, their ability to slake readily with a minimum addition of water to form a mixture of uniform consistency, the inactivity of the silt clay portion, the absence of excessive shrinkage, glue-like colloids, and high plasticity, and the gradation of the soil constituents (sands, soils, and clays). For this study, a wide variety prevailed which enabled the operators to study the suitability of various soils ranging from the sandy types to those predominating in clays.

Silts and clays when fluid form the paste or lubricating agent while the sands provide the stabilizing medium, but an excess of sand tends towards harshness, which generally decreases as the sand percentage and sizes of particles decrease. For that reason, a fine sand fraction is preferable to furnish the required stability and to reduce the shrinkage upon drying. To eliminate objectionable harshness, the proportion of silts and clays to the fine sand should be such that the sand particles are completely covered.

Top Soils Generally Best Suited

The top soils are generally best suited for this work, and for the most part, natural stability in the field and the absence of appreciable erosion indicates the presence of the more desirable soils. Also, the more suitable soils are generally the easiest to work in the pit, screen and load. An experienced operator can usually detect such soils with reasonable accuracy, but his judgment should in all instances be supported by laboratory tests. These tests consist primarily of the lower liquid limit, the shrinkage limit, and the mechanical analysis.

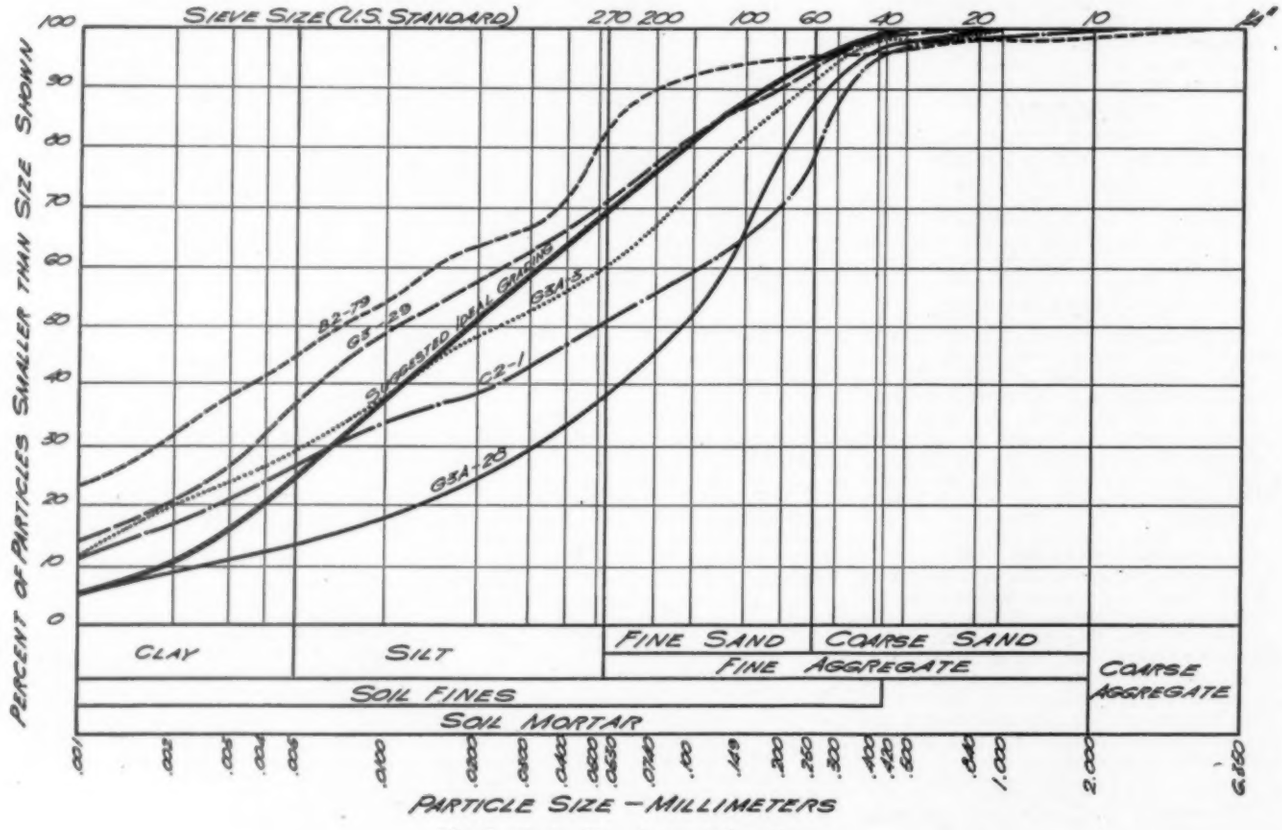


Fig. 1—Grain Size Accumulation Curves

SOIL TESTS

Sample No.	Upper Liquid Limit	Lower Plastic Limit	Plastic Index	Shrinkage Limit	Shrinkage Ratio	Shrinkage Volume	Linear Shrinkage	Field Moist Equiv.	Mechanical Analysis: Gravel	Coarse Sand	Fine Sand	Silt	Clay	Colloids	Class
G3A-28	276	229	47	28.5	1.66	6.6	2.2	26.1	0.0	12.0	44.5	30.0	15.6	5.2	A-4 b
G3A-29	40.0	22.2	17.8	13.7	1.79	26.5	9.0	27.1	0.0	7.5	22.5	34.0	36.0	13.7	A-7-a
G3A-31	33.0	17.1	15.7	16.1	1.67	22.7	8.6	25.6	0.2	9.6	31.2	29.6	29.6	11.7	A-4
*G3A-32	41.5	24.1	17.2	13.1	1.79	29.2	10.6	33.7	6.7	7.3	24.5	26.0	35.6	14.6	A-7-b
*B2A-17	31.5	17.1	14.2	14.6	1.85	23.9	9.1	26.6	0.4	13.6	31.5	26.9	27.7	11.0	A-4
C2-1	28.1	19.0	9.1	16.5	1.51	17.6	6.5	24.5	0.0	22.6	27.6	25.0	27.0	10.6	A-4
B2-79	67.6	31.0	36.6	13.4	1.09	46.2	19.2	41.0	1.2	3.0	14.6	35.6	44.0	22.6	A-7

* Sample G3A-32 similar to G3A-29 and are not discussed.
Sample B2A-17 similar to G3A-31
◎ Hand Method

The lower liquid limit (LLL) is the moisture content, in per cent of dry weight of soil, at which soils pass from the plastic to the liquid state.

The shrinkage limit (SL) is the moisture content, in per cent of dry weight of soil, at which a reduction in moisture content will not cause a decrease in volume of the soil mass, but at which an increase in moisture content will cause an increase in volume.

The mechanical analysis by the hydrometer method determines the grading.

The relation of the shrinkage limit to the lower liquid limit discloses the relative activity of the soil, as shrinkage limits equal to or greater than 75 per cent of the lower liquid limits indicate inactive soils with negligible shrinkage properties. The wider the range or difference between LLL and the SL, the greater the tendency for the soil to shrink.

A soil having an LLL of about 24 to 40 with an SL Approaching, equal to, or above 75 per cent of the LLL and with a grading analysis similar to or varying slightly from the suggested ideal grading curve on Figure 1 should be suitable.

Screening Suggested for All Soils

All of the soils for this study worked much better when screened. The additional handling dried the soils sufficiently to assure more rapid slaking and mixing, and to eliminate roots, rocks, and other extraneous objects likely to cause delay. Screening is suggested for all soils for both economical and practical reasons. One large rock, metal object, etc., overlooked by the laborers is sometimes sufficient to cause serious damage, resulting in costly delays.

Mixtures must possess certain essential qualities for use in mud-jacking, the absence of any one of which may be the cause for rejection or adjustment. They should be of such fluidity that they can be readily pumped, should become stable within a very short time, should spread rapidly beneath the pavement without undue harshness, and should be free of detrimental shrinkage. The fine soil fraction controls the fluidity, the cement insures rapid stability, the proportion of sand, silt and clay generally determines the harshness, and the cement reduces the shrinkage of the mix on loss of moisture.

Materials other than cement were used in this study to obtain rapid stability, to eliminate shrinkage, and or other desired qualities, but for the most part were not found to be practical. Mixtures containing dehydrated and hydrated lime, calcium chloride, soap, salt, both early strength and regular cement and combinations of the above were made in the laboratory. The mixtures other than those containing cement or certain lime cement combinations had one or several objectionable features. The lime and lime cement produced very smooth flowing mixtures, but generally decreased the rate of set. The decreased setting time was advantageous in areas where several lifts are required to rise sunken pavement slabs, but the final lift was a cement mixture to insure rapid stability. Where lime (hydrated) is used, a lime cement combination is suggested. Calcium chloride was used to quicken the setting time, but with no apparent change. Soap was added for the same reason as the lime, but was not found to be practical. Salt mixtures were not economical, practical, or beneficial. High early strength cement was not generally as satisfactory as the regular cement. In using the regular cement, it was found that after a certain quantity was added, additional cement was of no material benefit.

Five Soils Discussed

Seven soils were selected for this work. However. due to similarity of two of these soils, only five will be discussed. With these soils, numerous mixtures were prepared in the laboratory containing the before mentioned materials in various proportions. Those found to have suitable characteristics for mud-jacking and which seemed reasonably economical and practical were selected for trial in the field.

Soil G3A-28 was an inactive calcareous sandy loam which formed a mixture that worked well in the pump. However, the mixture leaned towards harshness due to the predominance of the sand fraction. Particularly was this true of the thicker mixtures, but which became less apparent in the thin or soupy mixtures. The addition of lime resulted in a smooth, easy working paste that seemed to spread satisfactorily.

Soil G3A-29 was a comparatively active silty clay that worked very satisfactorily in the pump and which formed a very smooth flowing mixture. However, because of the activity of the clay portion, additional cement was required to assure rapid stability and to reduce shrinkage. Comparatively large quantities of water were required to obtain the required consistency for these mixtures.

Soil G-3-A-31 was a comparatively active calcareous clay loam that worked with equal satisfaction as soil G-3A-29. Particular attention is directed to the effect of cement on these mixtures. Cement in excess of one sack per cubic yard of soil showed an increase in the rate of stability and in the shrinkage value.

Soil C2-1 was a moderately active sandy clay loam. The excess of sand resulted in packing both beneath the slab and in the mud-jack. Also, considerable wear on the mixing blades resulted due to the grinding effect of the sand particles. The effect of various cement quantities was significant. One-half sack of cement per cubic yard of soil seemed sufficient to control shrinkage. Soils having similar characteristics to this material should be rejected.

Soil B2-79 represented the active clays. The clay content was in excess of that required to form a smooth flowing paste. Jamming of the pumps was the result. Like C2-1, this or similar soils should not be used. The quantity of cement required to materially reduce shrinkage for such soils would be excessive.

After the soils were selected, the quantities of water and cement (or lime cement) were determined for each mixture.

The quantity of cement to be added was determined by trial. Cement was added in increments of ¼ bag until the SL approached the LLL, and further additions of cement had no material effect thereon. At this point it was assumed that additional cement was not particularly beneficial, as further shrinkage would be negligible.

TABLE SHOWING RESULTS OF USE OF VARIOUS MIXTURES WITH THREE SOIL TESTS

MIXTURES (per Cubic Yard)	G3A-28						G3A-29						G3A-31					
	LLL	SL	VOL SHR	LS	SETTG TIME h.m	PER CT WATER REQD.	LLL	SL	VOL SHR	LS	SETTG TIME h.m	PERCT WATER REQD.	LLL	SL	VOL SHR	LS	SETTG TIME h.m	PERCT WATER REQD.
SOIL (UNTREATED)	27.5	23.3	6.5	2.2		33.1	40.0	9.7	26.5	9.8		53.0	32.8	16.1	22.7	8.6		44.5
2 SACKS REG. CEMENT													34.8	26.7	11.2	3.4	6.10	47.1
1/2 " " "													34.8	28.0	9.5	3.2	7.20	47.0
1 SACK " " "	28.6	27.5	1.8	0.4	12.35	34.4	41.1	33.0	10.3	3.7	9.25	52.7	33.7	28.6	7.1	2.4	8.10	42.5
3/4 " " "	28.2	24.1	5.9	2.0	23.05	38.0	41.8	31.2	13.0	4.7	25.00	54.5	35.4	27.9	10.4	3.6	8.20	47.6
1/2 " " "	28.0	23.5	6.7	2.2	22.50	39.7	41.6	32.6	11.8	3.8	30.35	55.0	32.8	25.8	9.8	3.4	8.45	47.0
3/4 " " " 1/4 SK. HYD. LIME	27.6	25.7	3.1	1.0	22.25	42.0	40.9	31.6	11.7	4.1	24.55	55.0	32.9	25.5	10.5	3.7	23.20	48.3
1/2 " " " 1/2 " " "	31.6	25.1	9.4	3.2	23.30	39.8	39.8	30.7	11.8	4.2	30.35	55.1	32.1	24.9	10.4	3.6	22.35	48.7
1/4 " " " 3/4 " " "	30.0	24.2	8.4	2.9	26.50	41.1	40.4	30.8	12.4	4.4	41.30	57.8	34.1	23.7	14.4	5.1	15.10	
1 " HYD. LIME	30.5	22.2	12.0	4.1	47.05	42.0	42.2	30.3	15.0	5.2	43.35	58.0	34.4	22.0	17.1	6.0	50.05	46.0
3/4 " " "	31.1	23.2	11.4	4.0	46.40	42.3	42.8	30.5	15.8	5.5	46.30	59.2	33.0	21.1	16.6	5.8	49.35	
1/2 " " "	28.5	21.1	11.0	4.0	46.15		42.2	27.8	16.5	6.4	48.		35.0	21.2	18.8	6.7	49.	
3/4 " REG. CEMENT 1/4 SK. DEHYD. LIME	29.7	21.6	11.9	4.1	22.45		39.3	26.2	16.5	5.8	24.		31.3	21.6	13.7	4.9	44.15	
1/2 " " " 1/2 " " "	29.2	22.7	9.4	3.2	31.30		36.9	25.6	14.8	5.1	48.		30.3	20.3	14.1	5.0	23.35	
1/4 " " " 3/4 " " "	29.5	22.0	10.6	3.7	15.15		36.1	26.4	12.9	4.5	48.		31.1	24.1	9.9	3.4	23.55	
1 " DEHYD. LIME	29.4	21.1	12.1	4.1	71.05		34.6	26.3	11.1	3.9	39.25		30.2	21.4	12.3	4.3	24.25	
3/4 " " "	29.5	20.9	12.4	4.3	22.25		37.1	25.0	15.7	5.5	24.30		30.4	21.4	12.6	4.5	24.50	
1/2 " " "	29.4	21.4	11.6	4.1	22.00		35.9	25.0	14.5	5.1	24.55		32.7	21.6	15.6	5.3	24.	
1 " HIGH EARLY STRENGTH CEMENT	28.5	22.9	8.9	2.9	8.50		40.0	29.6	13.0	4.7	23.45		32.0	24.9	9.8	3.5	5.05	
3/4 " " " "	29.0	22.5	9.7	3.2	8.45		40.5	30.0	13.1	4.7	23.00		32.5	24.4	11.2	4.0	7.25	
1/2 " " " "	30.3	22.9	10.6	3.8	8.55		41.3	28.4	15.6	5.4	24.30		32.8	24.5	11.5	4.1	8.50	
3/4 " H.E.S. CMT. 1/4 SK DEHYD. LIME	28.4	21.8	9.7	3.3	26.45		37.6	26.1	14.7	5.2	30.10		31.0	23.1	11.3	3.9	23.00	
1/2 " " " 1/2 " " "	27.8	22.2	8.4	2.9	28.20		37.0	25.8	14.4	5.1	27.10		31.2	23.2	11.2	4.0	14.45	
1/4 " " " 3/4 " " "	28.2	21.9	9.4	3.2	42.15		36.4	26.0	13.5	4.8	26.00		30.3	23.9	19.2	5.2	19.00	
1 " INTERMEDIATE GRADE H.E.S. CEMENT	28.3	22.7	8.4	2.8	8.45		40.2	30.4	12.2	4.3	9.		32.0	24.2	10.8	3.8	8.05	
1/2 " INTERM. GR. H.E.S. CMT. - 1/2 SK. DEHY. LIME	26.9	21.2	8.6	2.9	30.40		38.1	26.1	15.4	5.4	25.00		31.1	22.3	12.5	4.3	9.	
1/4 " " " " " - 3/4 " " "	26.9	20.9	9.0	3.1	30.20		38.4	26.9	14.8	5.2	31.05		31.8	22.1	13.5	4.8	20.10	
30% SALT SOLUTION (BY WEIGHT)	26.9	18.3	13.3	4.8	NO SET		35.2	20.8	19.9	7.1	NO SET							
10% " " "	24.8	22.2	14.3	1.4	NO SET		36.2	24.2	16.4	5.8	NO SET							
5% " " "	26.0	22.7	15.0	1.8	NO SET		32.0	29.0	4.2	1.4	NO SET							
1 SACK REG. CEMENT & SOAP SOLUTION (5 GR/1)	31.0	23.8	9.9	3.4	22.55		41.0	28.5	14.9	5.2	8.00		31.7	24.8	9.9	3.7		
1 " HYD. LIME	30.9	21.4	12.9	4.7	46.10		47.0	25.7	23.9	8.8	43.00		36.3	21.1	19.2	6.8		
10% LIMESTONE DUST (BY WEIGHT)	25.8	16.0	15.3	5.5	70.		36.6	15.6	27.4	10.1	120.00		31.6	14.6	24.0	8.8	70.00	
1 SACK REG. CEMENT 10% LIMESTONE DUST (BY WEIGHT)	27.0	21.4	8.3	2.9	9.		38.4	27.5	13.8	4.9	23.40		30.4	23.3	10.2	3.7	9.00	
			C2-1						B2-79									
1 SOIL (UNTREATED)	28.1	16.3	17.6	6.3		41.0	57.3	13.4	45.2	16.2		67.8						
1 1/2 SACKS REGULAR CEMENT	29.3	23.3	8.9	3.0		44.4	49.6	35.2	16.6	5.7		66.8						
1 SACK " " "	30.1	23.5	9.3	3.3		44.4	51.8	33.0	20.7	7.3		69.9						
3/4 " " "	30.9	23.5	10.4	3.7		41.6	53.6	30.5	24.7	9.1		67.7						
1/2 " " "	30.6	23.2	10.6	3.8		44.5	55.8	28.9	28.2	10.6		70.2						

Determination of Water Required

The percentage of water required to give the mixture the desired fluidity was determined with a mechanical device for making the LLL test. The LLL is the consistency at which 25 shocks or blows will close a groove of soil. However, it was impractical to manipulate the sample until exactly 25 blows would close the groove. Therefore, by plotting the number of blows against the per cent of moisture at different consistencies of a semilogarithmic graph, the flow curve (straight line) gave the relative consistency at different moisture contents. The point where the flow curve intersected the 25 blows, was the LLL. Likewise, by extending the curve to correspond to 0.1 blow, the percentage of water required to furnish the necessary fluidity for mud-jacking was determined. The moisture percentage of the soil in the pit was determined and subtracted from the total required. However, the water was varied slightly in the field from the flow curve determinations by reason of pit moisture content fluctuations and slight soil type variations. Also, where cavities existed beneath the pavement, less water was required to obtain the desired spread. The normal consistency, however, was such that the mixture would flow freely and spread completely on an open surface under its own weight.

Location and Spacing of Holes

The location and the spacing of holes proved to be very important in securing satisfactory work. At first, the holes were spaced in the usual manner. The edge holes were spaced on 6-ft. centers, 2 ft. from the pavement edge. The middle holes or those 1 ft. offset of the centerline, were staggered with the edge holes and the centerline. As in the past, considerable breakage and cracking resulted. Therefore, the spacing of the edge holes was shortened to approximately 4 ft. centers, 3 ft. from the pavement edge. The middle holes were staggered accordingly in the usual manner with the edge holes. This resulted in more uniform spread of the mixtures, and less cracking and breakage.

After drilling the holes, the pavement was ready to be raised. In this work, no attempt was made to raise the pavement to its original grade, but to obtain, primarily, a comfortably smooth riding surface. Best results were obtained by working back and forth over a slab so that the raising operations were gradual. The modifications on the mud-jack were such that this procedure was simplified without loss of pumping time in moving from one hole to another. The dual hose arrangement permitted more or less continuous pumping without having to release the clutch in moving the hose from one hole to another. The cock on one hose was closed, moved and reopened. The other moved in like manner. By frequent moving the hose in adjoining holes, the area to be raised was doubled, thereby reducing breakage and cracking.

Pumping Operation

The sequence in pumping the holes was carefully performed. It was found that less cracking developed when the operation was begun at the middle holes near the midpoint of the slab and the hose moved alternately along these holes to the ends of the slab before the edge holes were pumped.

For the initial lift, the hose were moved with quick progression with only sufficient paste being pumped in

each hole to break the bond between the subgrade and the pavement, or to "float" the slab on a thin layer of mud. Extreme care was exercised during the initial lift not to force the mixture too rapidly, as the pavement seemed more susceptible to breakage and cracking at this operation. A steel pin driven at an incline in each hole prior to pumping, assisted materially in easing the flow of mud. Pronounced slab depressions were corrected in several lifts on alternate days in order that the adjustments be gradual.

A concrete mixer was employed to dry mix the soil and cement (or lime cement) at the soil pit in the proper proportions. This method was tried in an attempt to obtain uniformity of the mixture. However, this procedure did not control the water at the mud-jack as it was added in the usual manner, at the discretion of the operator. As the concrete mixer was not reasonably practical or economical and for other reasons stated above, it was abandoned, and auxiliary mixing and proportioning units were designed and added to the mud-jack.

With the redesigned machine, the screened soil was shoveled from a truck into one side of the hopper, and the cement (or lime cement) added by the operator with a measuring can. Approximately one-half of the water was then discharged from the gauged auxiliary water tanks into the mixing conveyor box before the cement and dirt were released thereon. As this material was being mixed and carried forward into the lower or main mixing unit, the procedure was repeated, only in this operation the other side of the hopper was used. The additional mixing unit resulted in a greater volume of uniformly consistent mud. Under normal conditions, the machine mixed and pumped all of the material that could be shoveled into the hopper by two laborers. During field operations, the weather conditions varied extremely. It was noted in particular that the pavement was more susceptible to cracking and breakage during the cold periods.

General Costs

Cost data was kept on this work, but due to the numerous changes in mixtures and methods of operation, to prolonged inclement weather and to the continued overhead during the period at which the mud-jack was being rebuilt and overhauled, the total charges are not representative of actual working conditions. Should the charges be separated for each of the various mixtures or operations, it would involve the preparation of a statement based on averages and deductions, rather than on actual costs accruing from a single continuous procedure. For that reason, only general costs will be shown.

COSTS FOR MUD-JACKING

County	Highway	Total CY	Total SY	Total Cost	Unit Cost Per SY
Guadalupe	3	498	13,115	$3,826.82	$0.29
Bexar	3	206	4,919	1,494.67	0.30
Comal	2	72	2,005	585.57	0.29
Bexar	2	30	1,192	302.02	0.25

By comparing the above square yard costs with other available data, it was noted that the above costs apparently exceeded those in other sections. On checking the available costs, it seemed evident that subsequent lifts of the same pavement sections were reported separately, as the total square yardage raised was in excess of the total square yardage on the project. In other words, if a slab required several lifts on separate days, the total square yardage was reported for each of those days. The unit costs reported above are based on the actual number of square yards of pavement raised regardless of the number of lifts required. On that basis, the above costs are not excessive. Calculations for the number of square yards raised were made 4 ft. from the outside holes, except at expansion joints, then measurements were made from them.

Summary

(1) Soils tests are suggested for all mud-jack work to predetermine their suitability.
(2) The screening of all soils is suggested.
(3) Cement was the most suitable stabilizing medium of the materials studied.
(4) Thin mixtures or those equivalent in consistency to 0.1 blow on the LLL device assured rapid mixing, complete and uniform spread, resulting in less cracking and breakage.
(5) The holes should be properly spaced. Close spacing is suggested.
(6) The sequence in pumping the holes should be carefully performed.
(7) The hose should be moved frequently in *adjoining holes*. Best results were obtained by pumping back and forth over a slab so that the raising operations be gradual.
(8) Extreme care should be taken in the initial lift, as the pavement seems more susceptible to cracking at this stage.
(9) For some soils, the addition of cement above a certain quantity increases rather than decreases the shrinkage.
(10) Best results were obtained in moderate and warm weather.

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Humphries Appointed District Engineer for P.C.A.

The appointment of H. D. Humphries as District Engineer of its Atlanta, Ga., office, with supervision over the work in Georgia, Florida and South Carolina, has just been announced by Wm. M. Kinney, General Manager of the Portland Cement Association.

Humphries, who succeeds J. M. Marshall, Jr., resigned, came to the Association in 1933 as a field engineer in Georgia. He was appointed District Engineer of the Association's Richmond, Va., office in 1936.

Prior to his service with the Association, he held several responsible engineering positions with firms in Georgia, Kentucky and Tennessee.

Humphries is a graduate of the Georgia School of Technology, where he obtained a degree in civil engineering in 1922.

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ROAD ADMINISTRATION IN ENGLAND AND WALES—There are 822 road administration authorities in England and Wales, excluding London, comprising 60 counties, 82 county boroughs, 230 claiming authorities, 313 urban and 137 rural delegated authorities. The boundaries of these authorities bear no relation to the mileage of their roads, to the distribution of the population they have to serve, or to the volume of traffic they have to carry.

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TRAFFIC ACCIDENTS CAUSED MORE DEATHS THAN U. S. WARS.—A total of 244,000 American soldiers were killed or died of wounds in the 15 years occupied by the country's major wars since 1776, while almost twice that number, or 442,000 persons, have died in traffic accidents in the past 15 years of peace, according to the Travelers Insurance Co.

HERE'S $63,000,000 OF PWA WORK

UP to June 27 approval had been given to 1,432 projects on the new PWA program. Included in the list are 51 projects for roads, 111 projects for street improvements and 48 projects for new bridges. The estimated cost of these 210 projects is $63,201,751, of which $12,919,893 is for road work, $15,400,205 for street improvements and $34,891,653 for bridges. It is expected that contracts for most of these projects will be let within 60 days. The 210 projects, many of which include several jobs, follow:

Gadsden, Ala.—Steel bridge with turn span and steel approaches supported on timber trestle bents over Coosa River. Estimated total cost, $163,636; grant, 45%, $73,636; loan, $90,000.

Douglas, Ariz.—Curbs, gutters, paving and sidewalks on 15th St. Estimated total cost, $33,751; grant, 45%, $15,188.

Douglas, Ariz.—Paving, sidewalks for portions of 16th St. and 17th St. Grant, $28,035; estimated total cost, $62,300.

Douglas, Ariz.—Street improvements: Paving, sidewalks, and appurtenant work on Green St. Grant, 45%, $15,750; estimated total cost, $35,000.

Phoenix, Ariz.—Asphaltic pavement and curbs, drainage structures, etc., on portions of McKinley St., Pierce St., Polk St., Fillmore St., Taylor St., Sixteenth Ave., Fourteenth Ave., Twelfth Ave., Tenth Ave., Fifteenth Ave., and Thirteenth Ave. Estimated total cost, $110,570; grant, 45%, $49,756.

Phoenix, Ariz.—Paving, sidewalks, drainage on Monroe, Adams, Park, Tenth and Fifteenth Sts. Estimated total cost, $96,586; grant, 45%, $43,464.

Phoenix, Ariz.—Paving, sidewalks, drainage on Garfield, Fillmore, Taylor, Polk, 10th, 11th, 12th and 13th Sts. Estimated total cost, $222,320; grant, 45%, $100,044.

Phoenix, Ariz.—Asphaltic pavement and appurtenant curbs, drainage structures, etc., on Monroe and Adams Sts., Jefferson St., Madison and Jackson Sts., 22nd Ave., 21st Ave. and 20th Ave. Estimated total cost, $197,456; grant, 45%, $88,855.

Phoenix, Ariz.—Asphaltic pavement and appurtenant curbs on portions of Oakland Ave., 18th Ave., and 16th Ave. Estimated total cost, $63,992; grant, 45%, $28,796.

Phoenix, Ariz.—Concrete and cut back asphalt pavement, curbs, etc., on portions of 14th Ave., 12th Ave., 11th Ave., 10th Ave., and 8th and 9th Aves. Estimated total cost, $69,760; grant, 45%, $31,392.

Phoenix, Ariz.—Paving, sidewalks, storm sewers in city. Estimated total cost, $109,000; grant, 45%, $49,050.

Phoenix, Ariz.—Paving, walks on Garfield and McKinley Sts. Estimated total cost, $17,786; grant, 45%, $8,004.

Phoenix, Ariz.—Concrete pavement, concrete sidewalks, curbs and gutters. Grant, $33,035; estimated total cost, $73,412.

Tucson, Ariz.—Asphaltic pavement, drainage structures and necessary house connections. "University Manor District Paving Improvement." Estimated total cost, $151.853; grant, 45%, $68,334.

Tucson, Ariz.—Asphaltic pavement, sidewalk grading, curbs, sewer and water work and appurtenances. "4th Ave. and 22nd St. District Paving Improvement." Estimated total cost, $205,514; grant, 45%, $92,481.

Tucson, Ariz.—Asphaltic pavement and curbs, house sewers, water connections, etc., "Main St. and 18th St. District Paving Improvement." Estimated total cost, $87,469; grant, 45%, $39,361.

Tucson, Ariz.—Asphaltic pavement, drainage structures and house connections. "Tucson Blvd. and 3rd St. District Paving Improvement." Estimated total cost, $169,090; grant, 45%, $76,090.

Tucson, Ariz.—Asphaltic pavement and curb, including sewer and water house connections, etc., "7th St. and 8th St. District Paving Improvement, Campbell Ave. to Treat Ave." Estimated total cost, $138,368; grant, 45%, $62,266.

Tucson, Ariz.—Grading, curbing and paving with asphaltic concrete on various city streets, water and sewer connections included. Estimated total cost, $161,258; grant, 45%, $72,566.

Tucson, Ariz.—Asphaltic pavement, drainage structures and house connections, "12th Ave. and 4th St. District Paving Improvement." Estimated total cost, $133,532; grant, 45%, $60,089.

Tucson, Ariz.—Asphaltic concrete pavement and curbs, sewer and water-house connections, etc., "Helen St. and Mabel St. District Paving Improvement, Park Ave. to Campbell Ave." Estimated total cost, $139,601. Grant, 45%, $62,820.

Los Angeles, Calif.—Street improvements: bridges; storm drains and sanitary sewers; grading, paving, street surfacing, sidewalks, curbing, etc.; street lighting and traffic signals; beach protection and necessary appurtenant work in connection with such improvements. Project separated into 15 units at various locations. Grant, $1,131,904; estimated cost, $2,515,343.

Los Angeles, Calif.—Street improvements: grading, paving, sidewalks, curbing and appurtenances; street lighting, traffic signals, storm drains and sanitary sewers and appurtenances; bridges and pedestrian subway and incidental work in connection with such improvements; remodeling of channel pump and installation of fire hydrants. Proposed work separated into six units, to be done on Arroyo Drive and Figueroa St. Grant, $1,083,446; estimated cost, $2,407,657.

San Buenaventura, Calif.—Harbor improvements, consisting of wharves, dolphins, transit shed, roadway and appurtenances upon contemplated Government break water. Estimated total cost, $300,000; loan, $165,000; grant, 45%, $135,000.

San Mateo, Calif.—Fire engine house and drill tower with street improvements and improvements to the site, with appurtenant equipment. Grant, 45%, $12,420; estimated total cost, $27,600.

Colorado Springs, Colo.—Auto highway, retaining wall, and bridge. Present plans propose the relocation of a portion of the Pikes Peak Auto Highway, a reinforced concrete wall along the west bank of Monument Creek and a reinforced concrete and steel bridge over Shook's Run. Estimated total cost, $106,184; grant, 45%, $47,783.

Chester, Conn.—Pavement on Winthrop Rd. and appurtenant work. Grant, 45%, $36,248; estimated total cost, $80 550.

New Haven, Conn.—Highway bridge over Quinnipiac River, double bascule span and approach spans of steel and concrete on masonry substructure. Estimated total cost, $785,000; grant, 45%, $353,250.

North Stonington, Conn.—Macadam pavement, drainage structures on Cossaduck Hill Rd. Grant, 45%, $58,287; estimated total cost, $129,467.

Sterling, Conn.—Highway bridge and road improvements: concrete bridge and macadam surface on the main road. Estimated total cost, $106,255; grant, 45%, $47,815.

Boca Raton, Fla.—Double leaf bascule bridge over Intercoastal Canal, electrically operated, including two trestle approach spans and roadway approaches. Estimated total cost, $96,363; grant, 45%, $43,363.

Miami, Fla.—Bridge and approaches: bascule lift bridge with approaches. Grant, 45%, $18?,100; estimated total cost, $418,000.

Miami, Fla.—Highway viaduct and approaches across Biscayne Bay: reinforced concrete roadway on plate girder beams on concrete piers. The structure will have a bascule lift span. Loan, $784,000; grant, $641,454; estimated cost, $1,425,454.

Miami, Fla.—Harbor facilities and a causeway: dredging of slip and channel, and construction of steel sheet pile bulk-

heads, two 1-story steel framed metal-covered warehouses, and a concrete roadway on filled embankment and on steel viaducts which include a 2-leaf bascule span. Estimated total cost, $4,000,000; loan, $2,200,000; grant, 45%, $1,800,000.

Pensacola, Fla.—Highway bridge and approaches; draw span of single leaf, rolling lift construction. Estimated total cost, $54,545; grant, 45%, $24,545.

Cordele, Ga.—Street paving. Estimated total cost, $66,000; grant, 45%, $29,700.

Macon, Ga.—Street improvements: curbs and gutters, and storm sewers on several streets in residential section. Estimated total cost, $94,000; grant, 45%, $42,300.

Boise City, Ida.—Storm sewer and sanitary sewer, widen pavement of a section of Idaho St. and resurface various asphalt paved streets. Grant, 45%, $102,272; estimated total cost, $227,272.

Mountain Home, Ida.—Street improvements: grading, surfacing and oiling village streets. Grant, 45%, $13,909; estimated total cost, $30,909.

Illinois, State of—Concrete pavement, curbs, drainage structures, etc., on Route No. 102, DuPage and Cook Counties. Estimated total cost, $1,200,000; grant, 45%, $540,000.

Adams County, Ill.—Seven bridges and 19 culverts, including appurtenant work. Present plans provide for two I-beam bridges, one reinforced concrete bridge, and six reinforced concrete culverts on State Aid Route No. 2 between the villages of Loraine and Lima; and for one reinforced concrete slab bridge, three I-beam bridges and 13 reinforced concrete culverts on State Aid Route No. 10 between the village of Plainsville and State Aid Route No. 13 near village of Beverly. Estimated total cost, $60,000; grant, 45%, $27,000.

Belleville, Ill.—Concrete pavements with curbs, gutters, drainage structures, steel and concrete bridge. Grant, 45%, $55,636; estimated total cost, $123,636.

Chicago, Ill.—Remove existing viaduct and abutments and construct new steel and concrete viaduct, including the necessary shifting of track and reconstruction of approaches, over the I. C. R. R. at Monroe St.—Grant, 45%, $197,640; estimated total cost, $439,200.

Chicago, Ill.—Bathing beach at North Ave. and Lake Michigan, including pier, submerged bulkhead, fill, beach house, grade separation structures, concrete and asphalt paving with appurtenant drainage structures and lighting, parking space and landscaping.

Chicago, Ill.—Widen and construct pavement and walks with curbs, gutters; readjustment of water pipe; relocation of elevated structure columns on Ashland Blvd. between Lake St. and Warren Blvd. Grant, 45%, $67,500; estimated total cost, $150,000.

Chicago, Ill.—Viaduct approach, extending Wacker Drive from N. Michigan Ave. to Field Blvd. and to replace the existing dock. The present plan proposes a concrete incased steel viaduct, 109 ft. wide, founded on concrete caissons and the removal of the existing dock along the river channel and its replacement by a new concrete dock on wood piles. Grant, 45%, $1,252,636; estimated total cost, $2,783,636.

Chicago, Ill.—Subway under Grand Trunk Western Ry. tracks, together with approaches and necessary appurtenances. The present plan proposes three plate girder spans with concrete abutments found on piles and the paving of approach streets. Grant, 45%, $103,909; estimated total cost, $230,909.

Chicago, Ill. — Subway type grade separation, including necessary appurtenances. Present plans propose a concrete and steel structure under the C., M. & St. P. R. R. at N. Austin Ave. Estimated total cost, $1,210,600; grant, 45%, $544,770.

Chicago, Ill.—Steel and concrete bridge with approaches over the drainage canal at Western Ave. and Western Blvd.; a steel and concrete viaduct grade separation at Western Ave. and Western Blvd., and a temporary bridge for use during construction. Estimated total cost, $1,727,272; grant, 45%, $777,272.

Cicero, Ill.—Pavement, including necessary appurtenances. Present plan proposes the widening of an existing pavement and the removal of trees and extension of drainage structures. Grant, 45%, $15,545; estimated total cost, $34,545.

Cicero, Ill.—Concrete pavement, including necessary street appurtenances. Present plan proposes removal of existing pavement and construction of a concrete pavement with combined curb and gutter. Estimated total cost, $132,727; grant, 45%, $59,727.

Cicero, Ill.—Concrete pavement, including necessary appurtenances. Plan proposes the removal of existing pavement and the construction of a concrete pavement with combined curb and gutter. Estimated total cost, $103,636; grant, 45%, $46,636.

Cicero, Ill.—Reinforced concrete pavements and appurtenances. Grant, 45%, $14,727; estimated total cost, $32,727.

Crystal Lake, Ill.—Sewage treatment plant consisting of screen chamber, control building with pumps and all necessary equipment, digestion tank, sludge beds, necessary roads and water supply, and all appurtenant works. Estimated total cost, $100,000; grant, 45%, $45,000.

East St. Louis, Ill.—Interstate toll bridge across the Mississippi River: steel superstructure with concrete piers and deck and approaches connecting St. Clair Ave. in Stites Township with a point on Broadway between Florida and Mullanphy Sts. in St. Louis. Grant, 45%, $2,475,000; estimated total cost, $5,500,000.

East Peoria, Ill.—Concrete pavements with curbs, gutters on various streets. Estimated total cost, $120,000; grant, 45%, $54,000.

Edwardsville, Ill. — Reinforced concrete street pavement and curbs, drainage structures, sidewalk pavement, etc., on U. S. Highway No. 66. Grant, $60,300; estimated total cost, $134,000.

Lake County, Ill.—Concrete pavement with curbs, gutters, sewers on State Bond Issue Route No. 60. Grant, 45%, $189,000; estimated total cost, $420,000.

Macomb, Ill. — Concrete pavements with curbs, gutters, drainage structures. Estimated total cost, $81,818; grant, 45%, $36,818.

Madison County, Ill. — Grading, construction of bridges, railroad grade separation, drainage structures, and appurtenant work on Federal Aid Route 132. Present plan proposes seven highway structures over water and railroad rights-of-way and the filling and grading of approaches and connecting roadways. Grant, 45%, $798,875; estimated total cost, $1,775,000.

Moline, Ill.—Widening and repaving a portion of 6th Ave. with concrete pavement, including curbs and gutters. Grant, 45%, $14,885; estimated total cost, $33,077.

Orangeville, Ill.—Concrete pavements with curbs, gutters, on Main, East and High Sts. Grant, 45%, $24,120; estimated total cost, $53,600.

Peoria, Ill.—Concrete pavements with curbs and gutters. Estimated total cost, $239,290; grant, 45%, $107,680.

Springfield, Ill. — Pavements with curbs, gutters, walks. Grant, 45%, $74,258; estimated total cost, $165,018.

Warren County, Ill.—To improve state aid roads: application of traffic bound surfacing on unimproved roads with necessary culverts and bridges. Grant, 45%, $157,500; estimated total cost, $350,000.

Greendale, Ind.—Concrete pavement and appurtenances on Kansas St., Lawrence St., Brown St., and Okey Ave. Grant, 45%, $14,850; estimated total cost, $33,000.

Mishawaka, Ind.—Removing present pavement and resurfacing with asphalt and replacing curb where necessary. Grant, 45%, $101,610; estimated total cost, $225,800.

Dickinson County, Ia.—Road improvements: grading and graveling various roads in the county. Estimated total cost, $52,000; grant, 45%, $23,400.

Davenport, Ia.—Street and alley improvements: new paving, replacing old paving, and resurfacing various city streets and alleys with concrete, asphaltic concrete, and brick pavements and appurtenant work. Grant, $109,09'; total estimated cost, $242,440.

Bancroft, Ia.—Concrete pavements, including curbs, gutters, sewer and water connections. Estimated total cost, $38,181; grant, 45%, $17,181.

Iowa City, Ia.—Improvements to athletic field and campus, and additions and alterations to stadium facilities. Present plans propose improvements to athletic field, including repairs and resurfacing, a fence, concrete curb around track, and drainage; alterations and enlargements to stadium's toilet

and dressing room facilities; and the filling in and landscaping of an area around and between two campus buildings. Estimated total cost, $51,000; grant, 45%, $22,950.

Jefferson County, Ia. — Clearing and grading of county roads including the construction of two steel and concrete bridges, drainage structures and appurtenant work. Estimated total cost, $53,500; grant, 45%, $24,075.

Linn County, Ia.—Rock or gravel surfacing of various county roads. Grant, $24,120; Total estimated cost, $53,600.

Linn County, Ia.—Six bridges on secondary roads: five steel structures and one concrete box culvert type bridge. Estimated total cost, $67,000; grant, 45%, $30,150.

Linn County, Ia.—Clearing and grading approximately 26 miles of the county's secondary road system. Grant, $41,400; total estimated cost, $92,000.

Sioux City, Ia. — Grading, surfacing, bridges, necessary drainage structures and appurtenant work on various roads in the county. Grant, $160,200; total estimated cost, $356,000.

Washington, Ia.—Concrete pavement on the road to Elm Grove Cemetery. Grant, $5,400; total estimated cost, $12,000.

Wellman, Ia.—Bituminous macadam surfacing of various streets in the town. Grant, $22,500; total estimated cost, $50,000.

Worth County, Ia.—Grading, gravel surfacing, drainage structure, a new steel bridge on existing abutments and reerection of an old truss bridge on new concrete abutments and appurtenant work. Grant, $22,500; total estimated cost, $50,000.

Topeka, Kans.—Grading and paving of Brenner St. and construction of reinforced concrete bridge across Shunganunga Creek. Estimated total cost, $70,174; grant, 45%, $31,578.

Shreveport, La.—Concrete pavement, sidewalks and curbs, and the necessary drainage structures on Youree Drive. Estimated total cost, $18,050; estimated grant, 45%, $8,123.

Shreveport, La.—Concrete paving, sidewalks and curbs on Akard Ave. Estimated total cost, $8,000; estimated grant, 45%, $3,600.

Shreveport, La.—Concrete paving, sidewalks and curbs and the necessary drainage structures on Archer Ave. Estimated total cost, $19,057; estimated grant, 45%, $8,576.

Shreveport, La.—Concrete paving, sidewalks and curbs and the necessary drainage structures on Albany Ave. Estimated total cost, $90,000; estimated grant, 45%, $40,500.

Shreveport, La.—Concrete paving, sidewalks, curbs, gutters and necessary drainage structures on Oakley and Youree Drives. Estimated total cost, $140,000; estimated grant, 45%, $63,000.

Shreveport, La.—Concrete pavement, sidewalks and curbs, drainage structures and appurtenant work on McNeil St. Estimated total cost, $3,800; estimated grant, 45%, $1,710.

Shreveport, La.—Concrete paving, sidewalks and curbs, and the necessary drainage structures, on Anniston Ave. Estimated total cost, $13,500; estimated grant, 45%, $6,075.

Shreveport, La.—Concrete pavement, sidewalks and curbs, drainage structures and appurtenant work on Louisiana St. Estimated total cost, $4,400; estimated grant, 45%, $1,980.

Shreveport, La.—Construction of a drainage outlet, new bridge and repairs to a bridge and road, and accessories. Estimated total cost, $73,800; estimated grant, 45%, $33,210.

Walpole, Mass.—Sewers, street improvements and appurtenant work. Estimated total cost, $52,300; grant, 45%, $23,535.

Hyattsville, Md.—Bituminous concrete resurfacing and concrete paving, curbs, drainage. Estimated total cost, $135,000; grant, 45%, $60,750.

Riverdale, Md. — Concrete and macadam paving, curbs, drainage. Estimated total cost, $118,000; grant, 45%, $53,100.

Ecorse, Mich.—Underpass grade separation between Outer Drive and the tracks of three railroads. Estimated total cost, $472,684; grant, 45%, $212,708.

Grosse Point Shores, Mich.—New concrete pavement and curb. Grant, $10,636; estimated total cost, $23,636.

Monroe, Mich.—Port improvements: municipal dock, including highways and railroad facilities, wharf construction, transit shed, water mains and sewerage on a new Federal ship channel. Estimated total cost, $285,000; grant, 45%, $128,250.

South Haven, Mich.—Concrete pavement, curb and appurtenances. Estimated total cost, $83,620; grant, 45%, $37,629.

Crookston, Minn.—Concrete pavements, walks, curbs, gutters, drainage structures and appurtenant work. Estimated total cost, $52,374; estimated grant, 45%, $23,568.

Gilbert, Minn. — Black top pavements with appurtenant work. Estimated total cost, $40,114; estimated grant, 45%, $18,051.

Meeker County, Minn.—Grade highways and to construct drainage structures and appurtenant work. Estimated total cost, $39,000; estimated grant, 45%, $17,550.

Spring Grove, Minn.—Concrete pavements, walks, curbs, gutters, drainage structures. Estimated total cost, $50,000; estimated grant, 45%, $22,500.

Natchez, Miss.—Highway bridge and approaches: steel truss structure with necessary approach viaduct and roadways across the Mississippi River between Natchez, Mississippi and Vidalia, La. Estimated total cost, $2,500,000; grant, 45%, $1,125,000.

Waveland, Miss.—Reinforced concrete street pavement, including necessary grading. Estimated total cost, $43,695; loan, $24,000; grant, 45%, $19,663.

Carroll County, Mo.—Improvements to township roads: grading, surfacing, drainage structures and appurtenances. Grant, $35,181; estimated total cost, $78,181.

Kirksville, Mo.—Concrete paving and appurtenant works. Estimated total cost, $454,545; grant, 45%, $204,545.

Saline County, Mo. — Two steel and concrete highway bridges with approaches and appurtenant work. Grant, $608,220; estimated total cost, $1,351,600.

St. Joseph, Mo.—Concrete and asphaltic concrete paving of streets and alleys. Grant, $42,750; estimated total cost, $95,000.

Butte, Mont.—Resurfacing streets. Grant, $19,665; estimated total cost, $43,700.

Lincoln, Neb.—Paving, curbs, and gutters, and appurtenant work on approximately 2 miles of streets. Estimated total cost, $101,000; grant, 45%, $45,450.

Bogota, N. J.—Grade crossing elimination, including the acquisition of land: Concrete and steel viaduct with earth fill approaches to carry Fort Lee Road over Elm Ave., West Shore Ave., Leonia Ave. and tracks of West Shore R. R., together with a pedestrian underpass at present grade crossing. Estimated total cost, $663,500; grant, 45%, $211,500.

Cape May, N. J.—Four highway toll bridges and approaches, including the acquisition of necessary land: double leaf bascule and deck girder bridges with concrete piers and abutments, one located at Townsend's Inlet, two at Hereford Inlet, and one at Cold Spring Harbor. Estimated total cost, $1,654,545; loan, $910,000; grant, 45%, $744,545.

Hoboken, N. J.—Reconstruct viaduct roadway: roadway widening and resurfacing, sidewalks, hand rail, drainage and electrical systems, and appurtenant work on the 14th St. viaduct. Estimated total cost, $567,200; grant, 45%, $255,240.

Mercer County, N. J.—Street improvements, a bridge, improvements to two bridge approaches, and acquisition of necessary land. Estimated total cost, $82,235; grant, 45%, $37,006.

Rumson, N. J.—Highway bridge, including acquisition of necessary land: steel bascule span, steel girder and concrete trestle spans and removal of existing bridge. Estimated total cost, $1,140,000; grant, 45%, $513,000.

Weehawken, N. J.—Concrete pavement, sidewalks, retaining walls, embankments, guard rails, fences and appurtenant work. Estimated total cost, $497,000; grant, 45%, $223,650.

Buchanan, N. Y.—Bituminous and asphalt paving, curbs, on various streets. Estimated total cost, $42,500; grant, 45%, $19,125.

Elmira, N. Y.—Bridge across the Chemung River: 7-span, steel deck girder structure on concrete piers and the removal of the existing structure. Estimated total cost, $271,180; grant, 45%, $122,031.

Johnstown, N. Y.—Street improvements and two bridges: concrete pavement, curbs and appurtenant work on West State St., and concrete bridges across Cayadutta Creek. Estimated total cost, $87,861; grant, 45%, $39,537.

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Johnstown, N. Y.—Concrete pavement and curbs, etc., on Route No. 67, in Johnstown. Estimated total cost, $43,782; grant, 45%, $19,701.

New Rochelle, N. Y.—Highway bridge, over Pine Brook Blvd.: stone faced, concrete structure to carry traffic on Hutchinson River Parkway. Estimated total cost, $138,720; grant, 45%, $62,424.

New York, N. Y.—Grade crossing eliminations and works appurtenant thereto: street changes, including grading, paving, curbing, sidewalks, adjustments of water and sewer lines, and incidental work; for new highway bridges, pedestrian overhead walkways and approaches thereto, including grading retaining walls and culverts; and for changes in railway structures, track, signals, third rail and power lines, signal and communication lines, and incidental work. Estimated total cost, $739,000; grant, 45%, $332,550.

Shelter Island, N. Y.—Highway bridges and grade separation: two steel truss bridges from Shelter Island to the mainland, across Shelter Island Sound; a reinforced concrete structure, with a double-leaf, bascule lift span, across Great South Bay at Smith Point; a reinforced concrete, overhead grade separation across the Long Island Railroad on County Highway No. 46. Necessary approach roads, including grading, fill, surfacing and paving, included in the project. Estimated total cost, $3,638,181; loan, $880,000; grant, 45%, $1,637,181.

Staten Island, N. Y.—Grade crossing elimination: grade separations at seven streets or roads where they cross the Staten Island tracks and will include the erection of four new stations, repairing and repaving of streets, changing of sewer and water lines. Estimated total cost, $2,136,000; grant, 45%, $961,200.

Steuben County, N. Y.—Highway bridge, with necessary approach roads, across the Cohocton River on County Road No. 10: steel truss structure and bituminous surface approach roads, also the removal of the existing structure. Estimated total cost, $78,821; grant, 45%, $35,469.

Burlington, N. C.—Municipal improvements: street pavements, curbs and gutters, and incidental work; for extensions of water supply lines; for a garbage incinerator. Estimated total cost, $367,272; grant, 45%, $165,272.

Greenville, N. C.—Concrete pavements and appurtenant curbs, drainage structures, etc. Estimated total cost, $103,636; loan, $57,000; grant, 45%, $46,636.

Lincolnton, N. C.—Improvements to existing water works and streets: water mains, new elevated storage tank, alterations to existing tank, asphalt pavement, drainage, curbs, sidewalks and appurtenant work. Estimated total cost, $61,818; grant, 45%, $27,818.

Roanoke Rapids, N. C.—Concrete pavements, including grading, curbs, gutters, sidewalks and storm drainage. Estimated total cost, $290,909; loan, $16,000; grant, 45% $130,909.

Washington, N. C.—Paving streets in city and cemetery including curbs, sidewalks, drainage structures and appurtenant work, and the extension and improvement of water system. Estimated total cost, $98,181; grant, 45%, $44,181.

Whiteville, N. C.—Asphalt surfacing, drainage structures, grading, etc. Estimated total cost of project, $50,909; grant, 45%, $22,909.

Wilmington, N. C.—To construct street improvements. Concrete sidewalks, asphalt pavements, curbs drainage structures, etc. Estimated total cost, $100,000; grant, 45%, $45,000.

Akron, O.—Highway bridge and approaches; steel structure on East Market St.; widening and reconstruction of approaches, change in grade at College St., and lowering of railroad tracks. Grant, $80,000; estimated cost, $215,000.

Akron, O.—Brick pavement, curbs, drainage structures, etc., on Uhler and Cole Aves. Estimated total cost, $94,000; grant, 45%, $42,300.

Akron, O.—Widening, bituminous resurfacing, curbs, drainage structures, etc., on Newton St., E. North St. and Home Ave. Estimated total cost, $81,000; grant, 45%, $36,450.

Akron, O.—Grading, draining and paving on Gorge Blvd. and Archwood Ave. Estimated total cost, $57,000; grant, 45%, $25,650.

Akron, O.—Concrete paving, curbs, drainage lines on West Wilbeth Road and on East Wilbeth Road. Estimated total cost, $96,000; grant, 45%, $43,200.

Cincinnati, O.—Improvements of 11 sections of city streets, including grading, paving, sewers, drains, inlets, walks, water mains. Estimated total cost, $500,000; grant, 45%, $225,000.

Chickasha, Okla.—Two steel and concrete highway bridges over Line Creek. Estimated total cost, $27,272; grant, 45%, $12,272.

Fairview, Okla.—County highway improvements: drainage, bituminous sand-clay surfacing, steel bridge and appurtenances. Estimated total cost, $220,000; grant, 45%, $99,000.

La Grande, Ore.—Steel structure, across an irrigation canal near La Grande. Estimated total cost, $20,396; grant, 45%, $9,178.

Marshfield, Ore.—Present plans provide for the dismantling of existing ferry slips and the use of some salvaged material in the construction of wood trestle approaches to a steel swing bridge over Catching Slough on Coos River; and provide for regrading and surfacing of present embankments. Estimated total cost, $91,491; grant, 45%, $41,171.

Umatilla County, Ore.—Improve existing state highway; alignment and grade corrections and the placing of oil macadam. Estimated total cost, $44,615; grant, 45%, $20,077.

Ambridge, Penn.—Concrete paving, curbing and appurtenances. Grant, $14,898; total estimated project cost, $33,106.

Pittsburgh, Penn.—Highway bridge and approaches. Present plans propose to widen the roadway of and approaches to the Wilmot St. bridge. Grant, $141,696; total estimated project cost, $314,879.

Pittsburgh, Penn.—Reconstruct two highway bridges; new steel span and alterations of existing piers and approaches at Herrs Island Bridge and remove and replace the roadway paving and cutting out certain concrete and rebuild with gunite at Heaths Run Bridge. Grant, $66,150; total estimated project costs, $147,000.

Pawtucket, R. I.—125,000 sq. yds. of pavement, 22,000 lin. ft. of water mains, 22,000 lin. ft. water distribution lines, 20,000 lin. ft. of sewer lines and appurtenances. Grant, $366,750; estimated cost, $815,000.

Providence, R. I.—Extensions to municipal wharf and sea wall: construction of extensions to bulkheads, including necessary dredging, filling, roadways, tracks, water supply and drainage lines, and the construction of a two-story reinforced concrete building. Estimated total cost, $2,000,000; grant, 45%, $900,000.

West Warwick, R. I.—Bridge over the Pawtuxet River and railroad tracks; two separate concrete structures over river and railroad with a highway on embankment between structures. Estimated total cost, $175,000; grant, 45%, $78,750.

Beaufort County, S. C.—Steel superstructure bridge with draw span across Harbor River including concrete substructure and timber trestle approaches. Estimated total cost, $516,210; grant, 45%, $232,294.

Greenville, S. C.—Grading, topsoiling, asphaltic surfacing, concrete curbs and gutters on city streets. Grant, $90,000; estimated cost, $200,000.

Clinton, S. C.—Topsoiling and bituminous surfacing of various city streets. Grant, $22,500; estimated cost, $50,000.

Columbia, S. C.—Grading, preparation of subgrade and bituminous paving, curbs, sewer and water lines. Estimated total cost, $1,342,000; grant, 45%, $603,900.

Fort Mill, S. C.—Asphalt pavement, grading, curbs, and appurtenant work on city streets. Estimated total cost, $173,537; grant, 45%, $78,092.

Lancaster County, S. C.—To construct road improvements, including bridges: bituminous paving, concrete culverts, widening an existing bridge and construction of three new concrete bridges. Grant, $112,500; estimated cost, $250,000.

Newberry County, S. C.—Reshaping and surface treating with stone and bituminous various county roads. Grant, $92,454; estimated cost, $205,454.

Newberry, S. C.—Asphalt paving, concrete curbs and concrete sidewalks on various streets throughout the town. Estimated total cost, $190,000; grant, 45%, $85,500.

Ninety Six, S. C.—Top soiling, asphaltic surfacing, curbs, gutters, necessary drainage structures on various city streets. Grant, $11,700; estimated cost, $26,000.

SALVAGE

—*for taxpayers, a "BONUS"; for labor, a "BREAK"*

Brick pavements have an exclusive advantage of a broad economic nature. After long service, the brick units have high salvage value.

Salvaging and relaying old brick on their new base is rarely ever an emergency* matter from the traffic standpoint. And this flexibility as to *time* when the work may be done permits postponement from periods when labor is scarce to times when men need employment.

Thus, relaying does not compete with private employment in good times; it furnishes a backlog of needed hand-labor when labor must have employment.

In recent years the Works Progress Administration has utilized this work with splendid results. Salvage of 40-year brick has often run over 75%. Engineer Fred T. Williams reports 116% salvage at Sanford, Fla., where "on edge" brick were turned flatwise in the new pavement. WPA forces turned out a good job which should equal the service the 36-year brick had already rendered.

New or relaid, brick has the longest life and lowest upkeep. Safe. Pleasant to ride on. And the big salvage is a "bonus" to taxpayers and a "break" for labor. National Paving Brick Association, National Press Bldg., Washington, D. C.

**The Reason:* At any stage of service, brick resists damage from weather as well as traffic.

BRICK

LONGEST LIFE . . . LOWEST UPKEEP . . . GREATEST SALVAGE VALUE

Richland County, S. C.—Bituminous pavement, bridges, necessary drainage structures and appurtenant work on county roads. Grant, $173,749; estimated cost, $386,110.

Sumter, S. C.—Bituminous surfacing, concrete curbs, gutters, sidewalks, driveways, necessary drainage structures on city streets. Estimated total cost of project, $80,000; grant, 45%, $36,000.

Brookings, S. D.—Grading, graveling and bituminous surfacing of existing roadways. Estimated total cost, $92,883; grant, 45%, $41,800.

Howard, S. D.—Grading, concrete curbings and gutters and the construction of a gravel base course and bituminous wearing course pavement. Estimated total cost, $32,727; loan, $18,000; grant, 45%, $14,727.

Memphis, Tenn.—Concrete pavement, sidewalks, drainage structures. Estimated total cost, $102,752; grant, 45%, $46,238.

Memphis, Tenn.—Asphalt paving on concrete base, granite curbing, concrete sidewalks, driveways, drainage structures. Estimated total cost, $119,671; grant, 45%, $53,852.

Memphis, Tenn.—Removing worn out pavement and sidewalks; the construction of concrete pavement, sidewalks, drainage structures and appurtenant work including the moving and/or remodeling seven buildings on Chelsea Ave. Estimated total cost, $196,322; grant, 45%, $88,345.

Memphis, Tenn.—Removal and remodeling of existing buildings; construction of incidental curbing, drainage structures, sidewalks and driveways. Estimated total cost, $232,410; grant, 45%, $104,584.

Memphis, Tenn.—Widening, paving, curbing, drainage structures, sidewalks. Estimated total cost, $123,393; grant, 45%, $55,526.

Memphis, Tenn.—Two sections of concrete twin culverts; for removal of existing retaining walls and culverts; for adjustment of existing public service facilities; and for sidewalks, curbs and gutters at street intersections. Estimated total cost, $136,484; grant, 45%, $61,417.

Memphis, Tenn.—Concrete culvert and repairs. Estimated total cost, $362,411; grant, 45%, $163,085.

Memphis, Tenn.—Concrete pavement, draining structures. Estimated total cost, $357,412; grant, 45%, $160,835.

Angleton, Tex.—Steel structure across the Brazos river on the Angleton-Brazoria County Road. Grant, $102,272; estimated cost, $227,272.

Bee County, Tex.—Grading, drainage structures, caliche base with bituminous surfacing for county. Estimated total cost, $180,000; grant, 45%, $81,000.

Bee County, Tex.—Grading, drainage structures, base course and surface treatment on about 18 miles of country roads. Estimated total cost, $135,000; grant, 45%, $60,750.

Borger, Tex.—Improvements to athletic field; two grandstands, concrete, brick and wood frame structures and well, pump and distribution system and appurtenant work. Estimated total cost, $18,181; grant, 45%, $8,181.

El Paso County, Tex.—Improvements to county roads by flood protection structures: bridge, drain ditches, check dams, and appurtenances. Grant, $78,750; estimated cost, $175,000.

El Paso, Tex.—Remove an existing wood bridge and to construct a concrete bridge. Grant, $4,090; estimated cost, $9,090.

Fort Bend County, Tex.—Gravel surfacing and penetration treatment of various roads in the county. Estimated total cost, $307,000; grant, 45%, $138,150.

Fort Worth, Tex.—Reinforced concrete viaduct over railroads on Hattie St. Grant, $38,250; estimated cost, $85,000.

Fort Worth, Tex.—Removing existing surfacing and resurfacing, on present concrete base, with brick paving on Main and Houston Sts. Estimated total cost, $107,272; grant, 45%, $48,272.

Galveston, Tex.—To construct pavements and resurfacing of existing pavements. Estimated total cost, $60,000; grant, 45%, $27,000.

Galveston County, Tex.—Paving and appurtenant work for county. Estimated total cost, $30,000; grant, 45%, $13,500.

Hardin County, Tex.—Grading, concrete paving, bridges, necessary drainage structures on county roads. Estimated total cost, $1,594,000; grant, 45%, $717,300.

Houston, Tex.—Paving on 11th St. with 2-in. asphaltic wearing surface on 6-in. concrete base. Estimated total cost, $161,767; grant, 45%, $72,795.

Houston, Tex.—Asphaltic concrete wearing surface on concrete base, Westheimer Road. Estimated total cost, $44,000; grant, 45%, $19,800.

Houston, Tex.—Street paving on East 16th Ave. Grant, $13,500; estimated cost, $30,000.

Houston, Tex.—Building up existing shell base and surfacing with bituminous or asphaltic-concrete material on various city streets. Grant, $405,000; estimated cost, $90,000.

Johnson County, Tex.—Two highway bridges: steel truss and concrete piers and abutments. Grant, $4,500; estimated cost, $10,000.

Kilgore, Tex.—Concrete pavement, curbs on various city streets. Estimated total cost of project, $300,000; grant, 45%, $135,000.

Liberty County, Tex.—Pavements, drainage structures on county roads. Grant, $64,012; estimated cost, $142,250.

Lipscomb County, Tex.—Pavements, drainage structures on county roads. Grant, $29,250; estimated cost, $65,000.

Nueces County, Tex.—Grading, paving with various types of permanent paving, drainage structures on county roads. Estimated total cost, $1,020,000; grant, 45%, $459,000.

Port Arthur, Tex.—Pavements, curbs, gutters. Grant, $15,354; estimated cost, $34,120.

Port Arthur, Tex.—Steel and concrete bridge, on concrete piles, with steel swing span and necessary trestle approaches, over Lake Sabine; concrete approach roads and main highways. Estimated total cost, $745,454; grant, 45%, $335,454.

Sweetwater, Tex.—Paving, curbs, gutters. Grant, $81,000; estimated cost, $180,000.

Tyler, Tex.—Grading, brick and asphalt paving, concrete curb and gutter. Grant, $148,909; estimated cost, $330,909.

Victoria, Tex.—Paved streets and storm sewers. Grant, $162,000; estimated cost, $360,000.

Walker County, Tex.—Bridges and culverts on "farm-to-market" roads: timber bridge structures and metal culverts. Estimated total cost, $100,000; loan, $55,000; grant, 45%, $45,000.

Wharton County, Tex.—Hard surfacing existing county roads. Grant, $622,935; estimated cost, $1,384,300.

Vermont, State of—Six concrete and steel highway bridges. Grant, $54,574; total estimated cost, $121,275.

Vermont—Woodstock, Vershire, Winhall, Stowe, Irasburg—Six bridges of concrete and/or steel construction; all on the state highway system. Grant, $33,697; total estimated cost, $74,883.

Vermont—Essex County, Vermont—Five bridges of concrete and/or steel construction; on the state highway system. Grant, $64,504; total estimated cost, $143,342.

Brookline, Vt.—Steel and concrete bridge across Grassy Brook. Estimated total cost, $12,727; grant, 45%, $5,727.

Fair Haven, Vt.—Steel and concrete bridge, over Castleton River. Estimated total cost, $10,000; grant, 45%, $4,500.

Guilford, Vt.—Steel bridge with concrete abutments across Broad Brook. Estimated total cost, $12,727; grant, 45%, $5,727.

Hubbardton, Vt.—Three bridges of concrete construction across Giddings Stream. Estimated total cost, $11,818; grant, 45%, $5,318.

Pawlet, Vt.—Steel bridge with concrete abutments, across the Mettowee River. Grant, $4,254; total estimated cost, $9,454.

Tinmouth, Vt.—Two concrete structures on state highway Route No. 1. Estimated total cost, $8,545; grant, 45%, $3,845.

Woodstock, Vt.—Two bridges, one over Ottaquechee River and one over Barnard Stream. Estimated total cost, $54,545; Grant, 45%, $24,545.

Phoebus, Va.—Municipal building, sewer and street improvements. Estimated total cost, $70,909; grant, 45%, $31,909.

Richmond, Va.—Widening and paving city streets. Estimated total cost, $149,000; grant, 45%, $67,050.

Richmond, Va.—Deep water terminal; turning basin, transit shed, warehouse, railway connections, sidings, highway connections, water and electric supply systems, on the James River. Estimated total cost, $1,750,000; grant, 45%, $787,500.

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You get streamlined service when you order road steel from Bethlehem. First of all, the complete range of road steel products manufactured by this company enables you to concentrate your orders with a single source of supply, which often means a better freight rate and simplifies ordering. Second, your order, no matter what its size may be, is treated as a unit, with delivery dates arranged to keep pace with your working schedules. Last but not least, Bethlehem has warehouses at strategic points throughout the country. Warehouse stocks are kept up to par at all times, an important feature when you have to take an unforeseen emergency in your stride.

Before you start work on your next contract, make it a point to get in touch with the Bethlehem office nearest you. Having detailed information on Bethlehem's road steel service may be your key to a faster, more profitable pace in road building.

OTHER BETHLEHEM PRODUCTS FOR HIGHWAY BUILDING: Bar Mats—Welded Wire Fabric—Contraction Joints (Road Strip)—Reinforcing Bars—Dowels—Bar Ties—Highway Guards—Bethlehem Steel Sheet Piling—Bethlehem Steel H-Piling—Miscellaneous Products.

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Richmond, Va.—Grading, gravel surfacing, curb and gutter and appurtenances. Estimated total cost, $297,000; grant, 45%, $133,650.

Richmond, Va.—Pavement and curbs on various city streets. Grant, $34,650; total estimated cost, $77,000.

Richmond, Va.—Paving with various types of permanent pavement, curbs, gutters. Estimated total cost, $157,000; grant, 45%, $70,650.

Roanoke, Va.—Bridge across Roanoke River, having a steel superstructure supported by concrete piers. Grant, $149,265; total estimated cost, $331,700.

King County, Wash.—Widening and resurfacing with bituminous top on West Valley Road. Grant, $23,175; total estimated cost, $51,500.

King County, Wash.—Grading, paving. Grant, $13,050; total estimated cost, $29,000.

King County, Wash.—Grading, surfacing with crushed stone, drainage structures and appurtenant work on Secondary Road Project No. 14. Estimated total cost, $31,052; grant, 45%, $13,973.

King County, Wash.—Grading, surfacing with crushed stone, drainage structures on Secondary Road Project No. 97. Estimated total cost, $36,400; grant, 45%, $16,380.

King County, Wash.—Grading extensions of existing highways for county. Estimated total cost, $32,266; grant, 45%, $14,520.

King County, Wash.—Grading, drainage on the Bellevue-Phantom Lake-Lake Sammamish Road. Estimated total cost, $30,034; grant, 45%, $13,515.

King County, Wash.—Grading, drainage structures on various roads in county. Estimated total cost, $27,400; grant, 45%, $12,330.

King County, Wash.—Grading and paving a road for county. Estimated total cost, $117,368; grant, 45%, $52,816.

King County, Wash.—Grading and paving a portion of West Roxbury St. for county. Estimated total cost, $31,881; grant, 45%, $14,346.

King County, Wash.—Grading and paving roads, wood trestle, drainage structures. Grant, $11,826; total estimated cost, $26,280.

King County, Wash.—Concrete paving and appurtenant work on Lake Ballinger Road. Grant, $40,327; total estimated cost, $89,616.

King County, Wash.—Bituminous concrete, including grading, necessary drainage structures on county road. Grant, $11,340; total estimated cost, $25,200.

Pierce County, Wash.—Clearing, grading, minor drainage facilities, asphalt, concrete paving of 6 miles. Estimated total cost of project, $55,673; grant, 45%, $25,053.

Seattle, Wash.—Grading and repaving with concrete various streets in the city. Grant, $107,438; total estimated cost, $238,750.

Tacoma, Wash.—Highway bridge over Puget Sound: 2-lane bridge consisting of several deck steel truss spans and a suspension bridge. Grant, $2,700,000; total estimated cost, $6,000,000.

Tacoma, Wash.—Paving, sidewalks, curbs, general repairs and necessary drainage structures. Estimated total cost, $54,710; grant, 45%, $24,620.

Whatcom County, Wash.—Improvements to approximately 1.22 miles on the Guide Meridian Road: asphaltic concrete strip on each side of existing concrete pavement and covering of entire surface with an asphaltic wearing surface. Estimated total project cost, $28,000; grant, 45%, $12,600.

Whitman County, Wash.—To construct state highway improvements. Present plans propose grading, surfacing, drainage structures, bridge improvements and appurtenant work on the Inland Empire Highway. Estimated total cost, $213,596; grant, 45%, $95,850.

Yakima County, Wash.—Grading, concrete paving on county road. Estimated total cost, $71,000; grant, 45%, $31,950.

Chippewa Falls, Wis.—Steel truss, over Duncan Creek, on substructure previously completed. Grant, $11,700; total estimated cost, $26,000.

Green Bay, Wis.—Asphalt resurfacing, concrete paving, curbing, grading. Grant, $72,880; total estimated cost, $161,957.

Park Falls, Wis.—Grading, concrete paving, curbing, gutters, storm drains. Loan, $102,000; grant, $83,455; total estimated cost, $185,455.

Racine, Wis.—Concrete pavement, curb and gutter, and appurtenances. Grant, $32,400; total estimated cost, $72,000.

San Juan, Puerto Rico—Graving dock and operating equipment, railroad facilities, roads and walks. Estimated total cost, $1,767,273; loan, $972,000; grant, 45%, $795,273.

Vega Alta, Puerto Rico—Asphalt paving on stone base, concrete curbs and sidewalks. Estimated total cost, $37,274; loan, $20,500; grant, 45%, $16,774.

▼

Montana's Historic Markers

Notable and unique among the many projects which the Montana Highway Department has inaugurated for the pleasure and convenience of tourists are their new roadside historic markers. The traveler is apprised that he is approaching one of these markers by a neat triangular shaped pilot sign bearing the legend, HISTORIC POINT, 1,000 FEET. This warning gives even the speed maniacs ample time to stop. Each marker is placed parallel to the highway on an especially constructed turnout so that the tourist may park without hazard to himself or traffic.

The marker consists of a framed four by six feet panel swung from a cross beam which is supported at the ends by posts set in a base of field stone. Some of the cross pieces and posts are rough-sawed timber and some are logs. They seem to "belong" in either case with their surroundings. The cross pieces have been embellished with cleverly designed silhouettes apropos of the text appearing on the suspended panel. Some of these silhouettes are painted, and others have been given the appearance of weathered hand carving by sandblasting the background, thereby leaving the design in relief. Wagon trains, Indian camps, buffalo hunts, stage coaches and cattle herds are among the subjects depicted.

The text consists of several paragraphs telling the reader in an informal style just what happened in that vicinity years ago. Humor and western vernacular have been interjected and the printing is large enough to be easily read without leaving the car or suffering the eye strain so usual in trying to decipher the inscriptions on bronze tablets. Not all of the markers refer to historic events. Some of them tell the stranger about the customs and conditions of Indian and pioneer days in a whimsical way that amuses as well as informs.

All of the material has been prepared and written by Bob Fletcher, Plans and Traffic Engineer for the department, who is thoroughly conversant with western history and tradition.

The Montana State Highway Department has erected 98 of these markers. They not only serve as welcome breaks in a day's drive but out-of-state travelers, or "guests" as the Montanans prefer to call them, who read them in sequence can with the aid of these condensed sketches recreate the picturesque scenes of the old frontier and learn much about the country through which they are motoring.

The highways through the storied Treasure State are modern in construction, well marked and maintained and best of all you meet with delightful hospitality and courtesy. Out-of-state people are realizing more and more that Montana is a huge playground with broad plains and shining mountains within easy driving distance of home.

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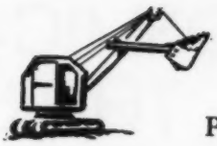

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INSLEY

COSMIC-RAYS AND THEIR CAUSE

By HALBERT P. GILLETTE

ACCORDING to Compton, cosmic-rays are electrified particles whose energy is comparable to that of star-light. Their enormous velocity gives them a penetrative ability that is astonishing. Because they enter the earth from all directions they are called cosmic. Their origin is still debatable.

The writer has shown that the emission of electrons by the earth and sun is probably due to the constant conversion of protons into radiant energy, and that both earth and sun are probably encased in series of electron-shells. In some of these solar shells the planets seem to have evolved.

It follows that any emitted stellar electron that penetrates the electron-shells that encase a star is constantly accelerated by the electric repulsion not only of the star's electron charge but by that of the electron-shells that encase the star. The pressure of radiant waves upon the electrons also accelerates them. So long as an electron is inside an electron-shell it experiences neither acceleration nor retardation by the electric forces of that shell; but as soon as it emerges, it is repelled electrically by all the electrons in that shell.

Judging by Bode's empirical law of planet distances and by other similar laws as to the distances of satellites, electron-shells tend to occur in series whose distances from some given electron-shell form a geometrical progression series whose ratio is two. This double progression is also found in electron-shells that encase the earth. Thus the Appleton shell is twice as high as the Kennelly-Heaviside shell. In the lower atmosphere a similar double progression is found both in ionized layers and in cloud distances above the earth's surface. And the same is true of upper regions where auroras are common. Indeed it seems probable to the writer that the impacts of high-speed solar electrons upon these electron-shells is the main cause of auroras.

It has recently been found that at Washington, D. C., there are more cosmic-rays about 11 a. m. than at any other time. This clearly indicates a solar origin of some of these rays. Since the earth's north magnetic pole is nearest the sun shortly prior to 11 a. m. at Washington, it is probable that this partly explains why this cosmic-ray maximum occurs when it does. About 18 years ago Mauchly pointed out "that the time of daily potential gradient maximum, as indicated by the ocean curves, corresponds approximately to the time when the earth's north magnetic pole is nearest the sun, while the daily minimum occurs, in a general way, when this pole is farthest from the sun." The sun emits electrons that must travel in spirals around solar magnetic lines of force, and therefore must have magnetic polarity. Hence those from the sun's southern hemisphere must be magnetically attracted by the earth's north magnetic pole. There is evidence that more electrons are emitted from the sun's southern than from its northern hemisphere, which seems to account for the phenomenon reported by Mauchly.

That the earth is encased in shells of ionized particles has been certain ever since Marconi sent the first radio signal across the Atlantic Ocean. These ionospheres are commonly believed to contain equal numbers of electrons (negative units) and protons (positive units), but the writer has long advocated the theory not only that electrons predominate in these shells but that shells exist beyond the confines of the atmosphere, forming a series of indefinite but prodigious extent. To form and maintain such a series it seems necessary only to assume that the cosmos contains enough molecules to act as a medium in which the induced electric and magnetic fields charges tend to "anchor" some of the electrons escaping from the central mass. It can be easily shown that if this is so, electrons will form rotating spherical shells around every great celestial mass, each shell lying midway between the two nearest shells; and that in a great series of such shells, equilibria will occur when their distances form one or more double progression series.

One of the most important of recent discoveries that support this theory is that made by Maj. A. W. Stevens whose photographs of the sun during an eclipse disclosed that the corona is a sphere. Perhaps the most significant feature of this sphere is that its diameter is double that of the sun.

There is evidence that adjacent to every solid there are electron-layers in the air. If so, they likewise probably exist at such distances from the surface of the solid as to form one or more double progression series.

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WPA Completes 19,272 Bridges

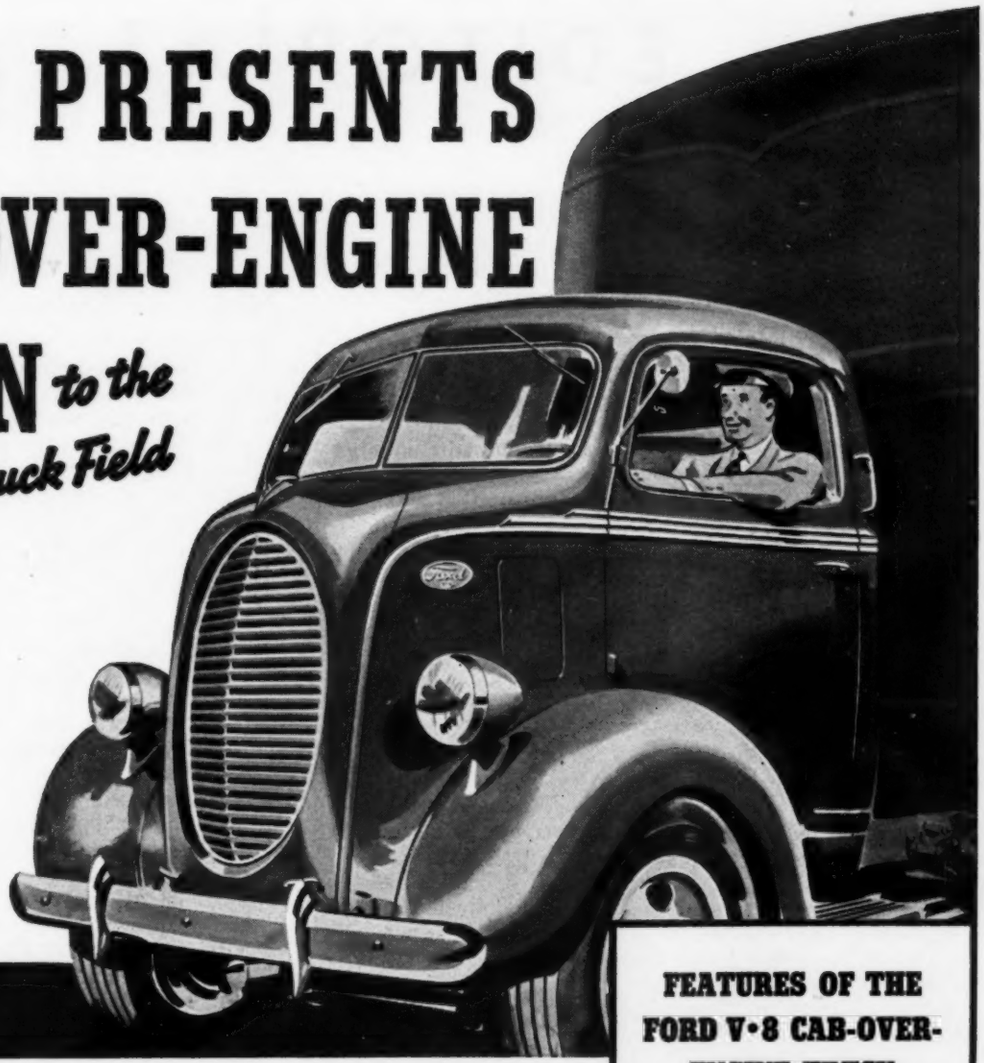
According to the latest available physical accomplishment figures (Oct. 1, 1937) the Works Progress Administration had completed projects involving the construction of 19,272 new bridges and the improvement of 13,166 old bridges. The greater proportion of these bridges embraced structures of wooden construction. In this class there were 14,150 new construction projects and 7,609 involving improvements. The overall length of new wooden bridges was 409,452 ft. as compared to the total of 612,521 ft. for all new bridge construction. The overall length of wooden bridges involved in improvement projects was 218,669 ft., while the total length of all bridges improved was 520,665 ft.

WPA has constructed new steel bridges to the number of 1,355 with an overall length of 81,684 ft.; and improved 4,324 old steel bridges, with an overall length of 255,595 ft. In the field of masonry type bridges the WPA has completed 3,767 new bridges with an overall length of 121,385 ft., and has improved 1,233 bridges with an overall length of 46,401 ft.

In addition, there have been constructed on WPA projects a total of 183,084 new culverts with an overall length of 4,902,451 ft. During the same period improvements were made on 30,061 old culverts, involving a length of 774,031 ft.

A great deal of WPA bridge construction work came about as a result of the destruction by floods during the last few years of hundreds of bridges in storm stricken areas throughout the country. Much of the other bridge construction work has been in connection with the construction and improvement of more than 145,000 miles of farm-to-market roads.

FORD PRESENTS CAB-OVER-ENGINE DESIGN *to the Low-priced Truck Field*



FOR YEARS truck owners and operators have asked for a low-priced cab-over-engine unit. Ford now answers this demand. The Ford V-8 Cab-Over-Engine is here.

The Ford V-8 Cab-Over-Engine is of advanced design, yet it utilizes time-and-service-proved features of Ford construction. Every detail has been planned to take the greatest advantage of a short wheelbase to provide increased payload space.

But most important of all features to be found in these new units is Ford Economy. Owners and operators everywhere report that the Ford Truck does more work, in less time, at lower cost. The reason—because Ford has found the way to make extra cylinders mean extra economy as well as finer performance.

Examine the Ford V-8 Cab-Over-Engine Truck at your Ford dealer's today. Then arrange for an "on-the-job" test with your own driver and your own loads over your own routes. No cost.

FEATURES OF THE FORD V•8 CAB-OVER-ENGINE TRUCK

- ★ 101-inch and 134-inch wheelbases.
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- ★ Easy steering.
- ★ Easy accessibility to engine.
- ★ Designed for convenient servicing.
- ★ Greater maneuverability in traffic.
- ★ Greatly increased payload space.
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- ★ Decreased turning radius.
- ★ Time-and-money-saving Ford Engine and Parts Exchange Plan.

FORD V·8 TRUCKS

MORE WORK IN LESS TIME AT LOWER COST ACCORDING TO OWNERS' RECORDS

EDITORIAL

Check All Clauses

IN practically every street or highway construction contract, the plans and specifications are made a part of the contract. Due to this fact, specification reviewers must be particularly careful to see that all clauses of specifications apply directly and particularly to the contract of which the specifications are to be made a part. It is customary practice to use standard specifications and change certain clauses to comply with the peculiarities of a particular job. Because engineers are still people and still subject to the vagaries of human shortcomings they must exercise particular care in the preparation of particular specifications. The laws and decisions of courts are inflexible when once written and interpreted. There seems to be no "give and take" to them. A recent court decision in New York, on which applications of certiorari for review of the U. S. Supreme Court were denied, has an important bearing on specification writing.

A representation or warranty as to the character of work to be done may be found in the drawings and specifications. If these are underestimated or understated and more expensive work is required, the contractor may be entitled to increased compensation. There are many cases which hold that an owner who puts forth a contract containing representations as to the character of material or other conditions affecting the work is responsible for the truth of such representations. There are other cases which hold that, if a contractor has done work according to the specifications furnished by the owner, he is entitled to be paid the contract price even though the result is not what the owner expected. The New York case holds that, where the owner has furnished specifications describing the work to be done, and where, because of physical conditions those specifications cannot be followed and more expensive work is required of the contractor, the owner must pay the increased cost.

The New York case is important to engineers, or owners, and contractors because the representation and warranty, which are the bases of the court's decisions, are usually contained in those sections of the specifications which establish the methods that the contractor must employ in performing the work. If the specifications, it is later discovered, cannot apply, the contractor must be reimbursed for the cost of extra constructions involved to complete the job.

The court held, however, as a note of warning to contractors, that notwithstanding the owner, the County of Westchester in this case, had called for a certain construction, the contractor is chargeable with whatever knowledge an engineer should have obtained from an inspection of the site and from the information furnished by the county prior to the bidding. If, after an inspection of the site, a study of the plans, and specifications, and information submitted by the owner (the county) the contractor should have known that the job could not be constructed as specified, he would not have a right to rely on the warranty contained in the specifications.

The contractor in the New York case was awarded extra costs. This decision brings out quite strikingly the necessity of getting as much information about a site as possible before construction starts and of checking the clauses of specifications in complete detail. It is the line of least resistance to pick up a set of standard specifications and include them, intoto, as part of a job contract without taking the necessary time to see that all clauses apply to the specific job.

▼

New Iowa Maintenance Policy

OF significance to street and road maintenance engineers is the trend toward what might be termed semi-stabilized maintenance. Many miles of gravel or other low cost aggregate roads are the best available for certain routes. Take Iowa for example.

For a good many years they maintained their gravel roads by carrying a coating of loose material on the surface at all times. Why take Iowa, alone on this point? Many miles has the writer traveled on these same kind of roads in North Dakota, South Dakota, Minnesota, New York, Alabama, Georgia, Texas, New Mexico, Arizona, etc. We take Iowa for our example because they have adopted a changed policy on maintenance of these roads; a policy worthy of commendation and comment.

During the last two or three years they experimented, on a number of widely separated sections of gravel road on the primary state system, by maintaining those sections as semi-stabilized roads. This led to the policy of dustless, semi-stabilized gravel roads. All loose material on the road surface and all additions of new material through the season must be stabilized. Accurate gradations of aggregate and amount of binder is basic in this program. A deliquescent salt will be used to retain moisture. The maintenance engineer has prepared instructions on how the work should be accomplished.

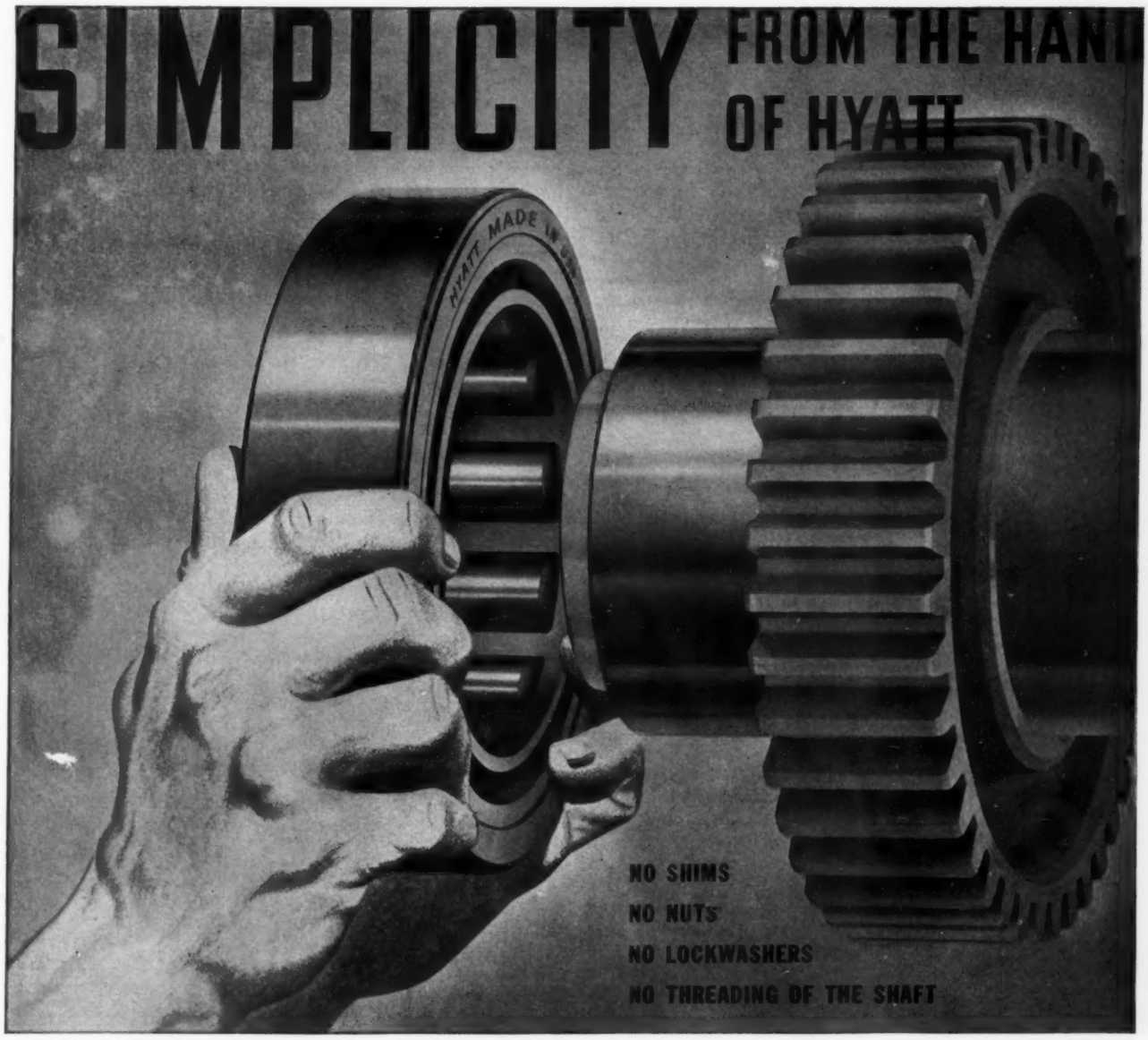
Michigan has followed this procedure with quite successful results. The motorist and the farm home family living along one of Iowa's new dustless gravel roads will appreciate the new maintenance policy. How the costs will work out are yet to be determined. Present results indicate the effort will be no more costly than by the old method.

▼

Increase Vigilance

WITH the advent of the summer touring and vacation season, heavy increases in motor vehicle traffic occur. More vigilance is consequently required to live up to the safety slogan, "Save Lives and Property." All highway department personnel, including city street administrative personnel, should be determined to bend effort toward the end that the accident ratio will be kept at a minimum. Not only should vehicles be checked for "one-eyed" cars, faulty brakes, rear view mirrors, windshield wipers, correct headlight adjustment, and skimmy stearing, but the streets and highways should be kept free and clear of mud and dust accumulations, roadsides should be mowed, loose gravel should be swept off the paved surfaces at road and street junctions, and signs or markers should be recently painted. Furthermore, "line-riders," and unnecessarily slow drivers should be stopped and cautioned by the highway patrol.

One source of annoyance is the inadequately marked detour. Local residents, the contractors on a job and the engineer may know the detour by heart. It may



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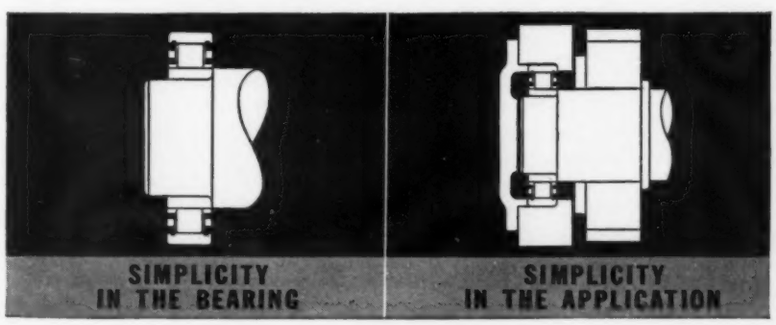

HYATT ROLLER BEARINGS

even be that a driver cannot get off the detour once he has started on it. Nevertheless, the detour sign should appear frequently; it gives a stranger a sense of security in his routing.

At the time this was written, a main route east out of Indianapolis is a case in point regarding the marking of detours. No detour markers, so far as the writer could find, told the traveler which way or where to go to get around the construction work. True, local residents may have known but the writer watched several seasoned travelers (salesmen) come up to the barricade and ponder. Some took a wrong direction and later returned to the barricade. Others struck out across lots to a dirt street which they hoped would lead them to a road that carried traffic beyond the construction. Detours should be marked plainly, very plainly.

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Questioning a Tradition

AN EDITORIAL in the June 23, 1938, issue of *Engineering News-Record* questions the advisability of transition spiraling on highway curves. We do not take issue with the final suggestion that it would be a good idea to put on record research information on the habits or characteristics of traffic in rounding curves, but we do take issue with the inference that spiraling is unnecessary.

The most logical maneuver in rounding a curve is to ease into or out of the change of direction. Many highway engineers hold that spiraling is wholly unnecessary as the same effect can be secured by pavement widening, thus permitting the motor-vehicle driver to "run his own spiral." This position is unquestionably correct, but the fact remains that the motor-vehicle driver eases his machine around a curve by traveling a spiraled path and it is equally true that the length of this spiraled path increases with the speed of the vehicle. One needs only to sit with the writer as he drives the highways of this country to learn the basic truth of this statement. In most cases, when running his own spiral on simple curves, the vehicle driver crosses the center line sometimes to the extent of occupying the entire opposing traffic lane. Vehicular speed is a fundamental factor in this picture.

It has been the usual practice, in order to prevent the vehicle from first encountering maximum superelevation at the beginning of the curve, to start to superelevate back on the tangent. This does two things: (1) it assists the driver to prepare for the turn, (2) it creates an external force which tends to deflect the vehicle from a straight line before that deviation is required by curvature. That actual deflection occurs can readily be confirmed by observing the tendency of cars, traveling on the outside lane at high speeds, to crowd the center line. Advance superelevation thus encourages drivers to cross the center line on a curve in "running his own spiral."

Extra pavement width started at the beginning of superelevation will provide a space for the driver to run his spiral but that extra width must be made available where he uses it—on the inside of his traffic lane, whether he's traveling on the inside or outside lane. This, of course, means extra cost. It is a cost that can be eliminated by building the pavement along the route naturally followed by traffic in changing direction at high speeds.

CONTRIBUTED EDITORIAL

Efficiency—The Construction Industry's Sin

THE W.P.A.'s continuing encroachment upon the public works construction market gives rise to the consideration of what factor W.P.A. has injected into the performance of construction work, which is lacking on similar work as performed by contract.

With waste and inefficiency evident on every hand where W.P.A. projects are in process, one is forced to the conclusion that the sin of the construction industry is its own efficiency.

In 1931, the A.G.C. promulgated its "Forward America" program for combating the depression and advocated an accelerated public works program as the vehicle for furnishing needed employment.

In 1933, the entire construction industry threw its weight behind the first big program for accelerated public works with the slogan "Work Relief instead of Dole Relief." W.P.A. was not then thought of—it was expected that this program would utilize the facilities of the construction industry and thus turn the wheel of all industry off dead-center. Five years later, construction finds itself hoist with its own petard.

Large sections of the public works market continue to be appropriated by W.P.A. Contractors are taboo on its work and construction workers are displaced by the less efficient workers of every other industry. Construction recognizes that relief must be given where needed but it insists that it is not fair to destroy the construction industry while giving relief, or ignore the prior right of construction workers to ply their occupations and force them to find places in other industries or gradually exhaust their resources and gravitate to a relief status in order to work at their accustomed trades.

Records reveal that 87 per cent of the employables on relief are concentrated on construction projects, while trained construction workers remain unemployed. Prevailing wages are alleged to be paid by W.P.A. but the hours are restricted so as to limit income. The prevailing wages are those established between private construction employers and their employees, yet both are ignored in so far as employment under the present W.P.A. policies are concerned.

Relative costs of doing public construction work under the W.P.A. plan, as compared with the record of the construction industry, are conclusively in favor of the contract method despite the testimony of the W.P.A. Administrator before the House Appropriations Committee that W.P.A. performance meets all requirements as to quality and that the cost is even less than the estimates of contractors under the same specifications. The testimony is refuted by the testimony of other Government officials appearing before other committees of Congress who state that increased appropriations are necessary if they are to be required to perform their operations under the W.P.A. methods, using relief labor.

Should the construction industry be permitted to function and utilize its own employees, the savings would go far toward providing the necessary finances for myriad other activities for those employables having no aptitude for construction work. It remains for the construction industry to continue a relentless program of familiarizing the public with the facts.

E. J. HARDING,

Managing Director, Associated General Contractors of America.

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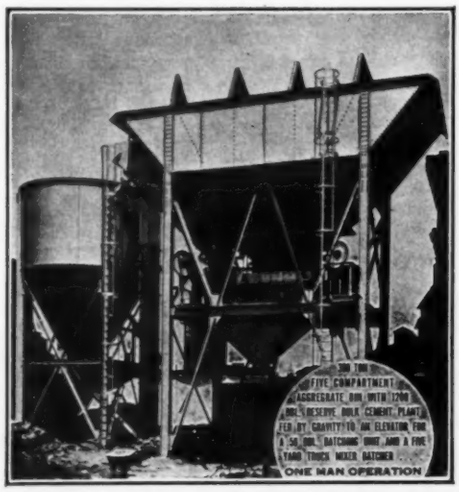
Whenever or wherever storage, batching or bulk cement plants are needed Heltzel-built equipment has always been the leader in point of service, ease of installation, economy of operation and length of service. Portable bins, built to suit the requirements of the concern whose base of operations change from place to place, are the only PORTABLE bins on the market.



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MICHIGAN POWER SHOVEL Co BENTON HARBOR, MICHIGAN, U.S.A.

NEW EQUIPMENT AND MATERIALS

New ¾ yd. Shovel

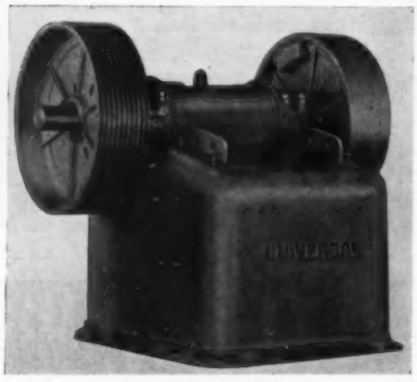
A new convertible shovel, dragline, crane and pull-shovel has been brought out by the Lima Locomotive Works, Inc., Shovel and Crane Division, Lima, O. It will be known as the "paymaster," this name having been selected as the result of a contest conducted at the 1938 Road Show. The Paymaster is a ¾ yd. shovel weighing 35,500 lbs. When equipped as a clamshell or dragline, capacity depends upon length of boom and material to be handled. When equipped as a crane, it has an 11-ton capacity. It is exceptionally fast with ample strength to give steady, dependable service in all kinds of work suited to a machine of ¾ yd. capacity. As a shovel it is equipped with an 18 ft. boom and 15 ft. dipper handle. Standard crane boom is 35 ft. However, inserts can be added to make a 50 ft. boom. Among the features of the machine are: Greater lifting capacities are possible without affecting the weight of the machine by the main machinery being placed to the extreme rear of the revolving frame. Machine revolves around a pintle cast integral with the base casting. The double flange roller path is also an integral part of the base casting. Four cone rollers of the hook type operate between the double roller path. All control levers are within the cab, and are of short, easy throw. Anti-friction bearings are used at all important bearing points, including drums. The rotating base is a one-piece casting with machinery supports mounted with finished bolts and spot-welded. Main clutches are the internal expanding band type, extra wide with large diameters, perfectly balanced to permit instant response to the movement of the operating levers. Swing and travel clutches are the double cone, friction type, amply ventilated. Modern welded construction is used extensively throughout the crawler truck. The truck is equipped with a lock for locking both crawlers while digging. The crawler treads are 22 in. wide. However, 30 in. treads can be furnished when necessary. Treads have six-point connections. The boom hoist is independent and exceptionally fast. Chain or cable crowd can be furnished. The boom is all-steel box type construction, welded throughout. The dipper handle is a single seamless tube 7 in. in diameter with a single rack welded the entire length of the handle. The power take off consists of a multiple roller chain operating in a bath of oil. The cab is pleasingly streamlined with in-built winter front, approximately two-thirds of the area of the cab can be opened for ventilation in hot weather. Ample vision can be had from any angle.

Lima Paymaster Equipped with 18 Ft. Boom, 15 Ft. Dipper Handle and ¾ Yd. Bucket, Working in Glacier National Park, Removing a Rock Slide.

▼

New Crusher

The Universal Crusher Co., Cedar Rapids, Ia., has introduced the new No. 2436 "Streamlined" crusher with 24 in. by 36 in. feed opening. Like the new No. 1016, this crusher has a one-piece alloy steel base with a smooth exterior, reinforcement being provided on the inside. This new "Streamlined" base construction provides approximately 20 per cent saving in weight which effects savings in freight and provides for greater portability. The entire base is flush at the bottom providing a firm footing, the bolt holes being on the same centers as ordinary models to allow for ready interchangeability. Other features include the six heavy duty roller bearings, two on the pitman and two on each side, quick acting product size adjustment, and wide feed opening. All major parts are made to be interchangeable with regular models of Universal 24 in. by 36 in. Crushers.



New Universal Crusher

▼

New Diesel Auto Patrol

A heavy-duty, self-propelled road grader, the Diesel No. 12 auto patrol, has been announced by Caterpillar Tractor Co., Peoria, Ill. The new machine has a wide range of useful blade positions. In addition to high or low bank cutting positions, the blade can be turned completely around on the full revolving circle. With ample clearance both front and rear, the blade is thus positioned for working in reverse gear. This feature will be valuable for sub-grade work, shaping bad spots, working short stretches or where turning is difficult. With the blade mounted in the center position on the blade beams, the new auto patrol is stated to permit a correct ditching position on either side, with the toe of the 12-ft. blade directly behind the front ditch wheel, and ample clearance to prevent clogging. A 6-cylinder "Caterpillar" Diesel engine delivers 66 brake horsepower, and is mounted over the driving axle to best utilize its weight in preventing wheel slippage. A gasoline starting engine insures easy starting regardless of atmospheric temperatures. The transmission offers six forward speeds and two reverse: A low speed of 1.8 m.p.m.; second speed, 2.8 m.p.h.; four higher speeds of 4.3, 6.8, 9.6, and 15.2 m.p.h. Reverse speeds are 2.4 and 3.8 m.p.h. The Diesel No. 12 auto patrol is equipped with two speed mechanical power controls. A simple shift of a lever in the gear box gives faster control for the longer blade movements on coarse work. For close finishing work, requiring extreme accuracy in blade settings, the slower control is quickly available. The new auto patrol is offered with tandem drive and leaning front wheels as standard equipment.

New "Caterpillar" Diesel Auto Patrol

▼

New 3½ S Tilting Mixer

Latest addition to the line of end discharge mixers of The Jaeger Machine Co., Columbus, O., is this 3½S "Speedster," a tilting type which features the same type of air-cooled engine which has become popular on Jaeger pumps. The 2½ H.P. plant is housed between drum and axle, making a very compact mixing unit. In addition to the saving of hundreds of pounds of weight, the end discharge design eliminates the need for turning or backing barrows when discharging and is said to be particularly convenient for backing up to foundations, windows or chuting. Machine is mounted on spring shock absorb-

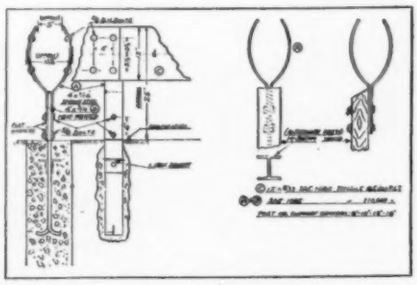
New Jaeger Tilting Mixer

ers, Timken bearings and pneumatic tires, with detachable towing pole for fast trailing and easy maneuvering. Standard Jaeger construction is used throughout, including patented "V" Spot drum with cone of Man-Ten steel, mounted on sealed Timken bearings.

▼

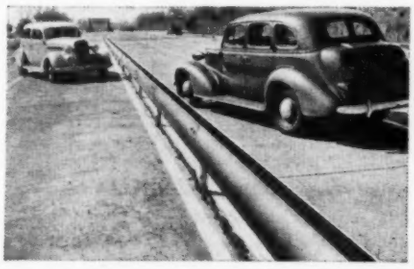
Road-Center Divider

The accompanying details and photograph show very clearly the character of the new road-center divider manufactured by United States Spring & Bumper Co.,



An Installation in Los Angeles with Cars Approaching in a Test

Los Angeles, Calif., under license from the Tuthill Spring Company of Chicago. The device is designed for the separation of lanes at points where space is at a premium. Its total width is less than that of an ordinary double stripe. Posts may be of wood, rolled sections, or flat spring steel. The photograph shows the latter



Section and Details—U. S. Center-Road Divider

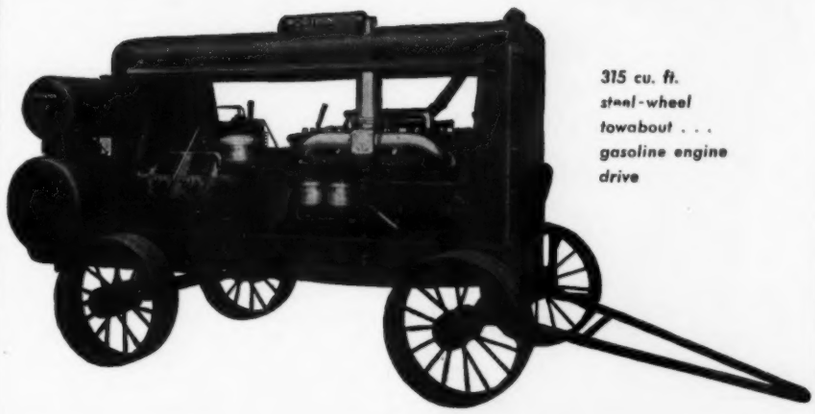
type, the metal having a ¾ in. by 4 in. cross section, heat-treated to give maximum strength and resiliency. Each convex rail has slotted rivet holes at one end to provide for expansion and contraction. Steel posts are set in concrete.

▼

New Traffic Line Marker

A new marker has been added to the line of "Straight Edge" markers manufactured by the G. N. Spiess Equipment Co., Milwaukee, Wis. It was designed for state and county highway departments and the larger cities where a large volume of highway traffic line is required. This Model "O" is a power driven machine and can be arranged to put down either a single or a double line of any desired width. It has a long wheelbase, enabling the operator to put down a straighter line. Any one with a few minutes' practice can handle the unit efficiently. The operation is entirely automatic. The proper amount of pressure to secure the best results with the

FOR LONG LIFE . . . ON THE TOUGHEST JOBS



315 cu. ft. steel-wheel towabout . . . gasoline engine drive

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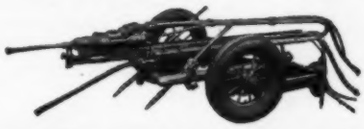

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Speeds up drilling...at any angle...on any job.
A light mobile rig...readily moved to any job where you can take a hand drill. This modern tool, and Worthington rock drills, breakers, sheeting drivers, trench diggers and tampers are further aids to profitable operation.

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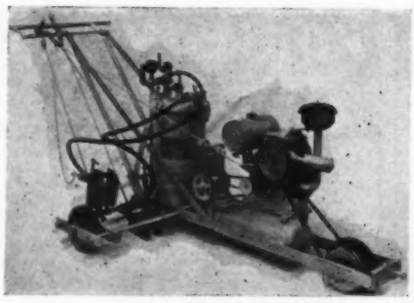


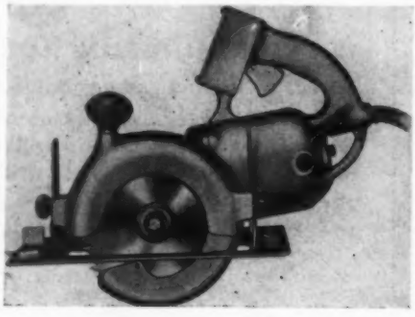
Model O Traffic Line Marker

material being used is constantly maintained by the compressor. When the travel clutch is thrown in the spray guns are opened up and remain so until the clutch is thrown out and the machine stopped. By raising the guns the machine may be operated without putting down a line. The Model "O" uses the same type spray gun that has been popular for over eight years on the other models of Spiess "Straight Edge" markers. It is stated to be practically non-clogging and to insure a line with clean cut edges, uniform coverage, better penetration and greater footage per gallon of material used. This spray gun will handle any material that can be sprayed. The Ohio State Highway Department has already placed its order for a number of these machines.

▼

New High Torque 2 in. Electric Saw

A new model portable electric saw of 2-in. cutting capacity has just been added to their line of tools by the Syntron Company, 384 Lexington Ave., Homer City, Pa. In design it incorporates all the newest features, including: Tilting base for bevel cuts; oversize, excess powered uni-



New 2-in. Portable Electric Saw

versal motor; double pole; underwriters' approved trigger switch; silent worm gear drive; and an automatic telescoping safety guard that has the official approval of the most rigid state safety commissions. Its light 18-lb. weight and nicely balanced handle position make it an easy tool for one-hand use. A 6½-in. combination rip and cross cut saw blade is supplied as standard equipment, however it will also use abrasive discs for slotting brick, tile, etc., to equal advantage.

▼

New Traffic Marker

A new traffic marker now being marketed by F. H. Bloomer, 39 Cortlandt St., New York, consists of a stainless steel strip 8½ in. long and 2 in. wide, to which is attached a die-cast zinc lense container 3¼ in. long and 2 in. wide. The lenses are inserted from the front and are held rigid by the use of specially designed clips, thereby enabling removal of the lenses without removing the traffic marker from the pavement, should it become necessary to do so. The lenses are the type silvered on the back and over it a protective coating is placed, thereby precluding the possibility of loss of reflective qualities. The lenses are so placed in the marker that they are at all times protected against damage or scoring through the impact of the wheels of motor vehicles. The marker is

New Traffic Marker

so designed that it will present no hazard to motor vehicles passing over them and will not cut or injure tires of vehicles whose wheels may come in contact with them. The design also includes the latest self-cleaning feature as the lenses will be kept clean by the cross-road wind and the wash of the rain due to the fact that there are no pockets in which dust and dirt can collect, all dust and dirt being swept out and around the marker by virtue of its self-cleaning design. The marker is fastened to the pavement by brush hammer drive anchors, which require a drilled hole in the pavement of ½ in. diameter by 1 in. depth.

▼

New Lightweight Jackhamer

A new jackhamer has been announced by the Ingersoll-Rand Co., 11 Broadway, New York, N. Y. It is a light weight yet extremely powerful drill, styled after the JA-45 and JA-55. It is claimed to do a surprising amount of work per cubic foot of air used, and will readily handle all general light Jackhamer work with ease. It is stated to have "that extra power" when necessary to handle a job ordinarily done by a heavier machine. Weighing less than 35 lbs., it is a light weight, easy holding, fast drilling machine that finds application in coal and metal mines, in quarries, and on construction jobs. It is light enough for cutting hitches, trimming, taking up bottom, placing trolley hangers in a mine, popholing and still powerful enough for much general work.

The JA-35

How to Bid and Make a Profit

ECONOMICS OF CONSTRUCTION MANAGEMENT

by

J. L. HARRISON

Engineer, Division of Management, U. S. Bureau Public Roads

This practical book is primarily concerned with the all-important question of bidding for a *Profit.*

The subject of Construction Management is treated by an author who has had practical contact with construction for 25 years. He has made a thorough study of administration and his present position on the staff of the Division of Management of the U. S. Bureau of Public Roads has allowed for close observation of construction problems.

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Because the compressor is water-cooled and two stage, power is saved and the final air temperature is greatly reduced. A Gardner-Denver *water-cooled* compressor operates efficiently anywhere, in any season.

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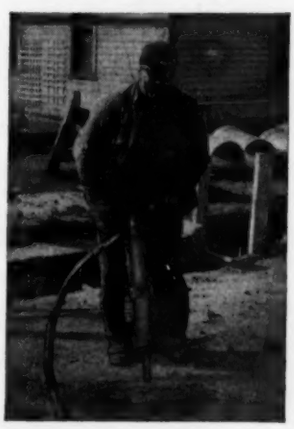

Gardner-Denver Sinkers and Paving Breakers have the capacity you need to get more work done in less time. Dependability keeps them on the job and out of the repair shop.

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—when you find out how Gardner-Denver equipment will cut your costs. We'll be glad to send you complete information and data concerning Gardner-Denver Portable Compressors and Drills. GARDNER-DENVER COMPANY, Quincy, Illinois.

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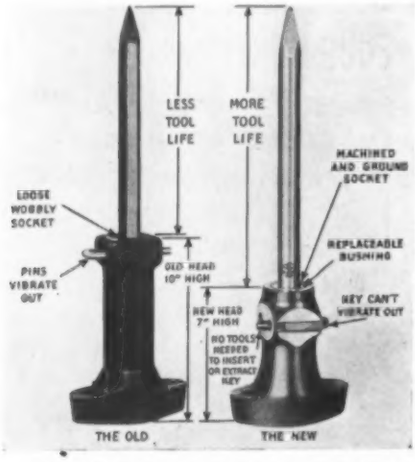
New Lower Head and a New Moil Point Without a Collar for Concrete Breakers

A new lower head and a new alloy moil point without a collar for concrete breakers has been placed on the market by the Quality Die Co., South Chicago, Ill. The



The Old Versus the New Lower Head

new Quality lower head is stated to be 3 ins. shorter than any head in service at the present time. It is made of alloy steel, heat-treated to give years of service. Fitted into the head is a replaceable hardened and ground steel bushing. The key that holds the new moil point without a collar in the lower head, locks itself in place and will not vibrate out in service. The new Quality moil point without a collar is claimed to eliminate the old trouble of breakage at the collar and increases the wearing length 3 ins., with the same overall length of point. The points are made of steel that has been tested and proved to give the best service in the work for which they are used.

▼

Reflecting Letters

A new line of reflecting letters and numerals for use in traffic signs, etc., has been introduced by Dura-Products Manufacturing Co., Canton, O. The reflecting letters and numerals are studded with mirrored glass jewel lenses which pick up rays of light and shine out brilliantly in the darkness. All lenses are cemented securely in place so they cannot be removed when the letter is in place in the sign. The characters are made of solid aluminum ¼ in. in thickness and are protected with weather resisting lacquer. In making a sign the letters or numerals are simply mounted on a wooden panel or other surface with rustproof screwnails.

▼

New Rock Breaker

A new pneumatic rock breaker has been announced by the Atlanta Steel Co., 1775 Broadway, New York, N. Y. No plugs and feathers or explosives are required in breaking the rock. In fact it is stated the tool breaks rock nearly 4½ times faster than when using feathers and wedges. The Atlantic breaker is used with the regular air equipment.

▼

WITH MANUFACTURERS

Jones & Laughlin Complete Wire Rope Plant

The completion of a modern wire rope plant at Muncy, Lycoming County, Pennsylvania, as an additional unit of its expansion and development program has been announced by the Jones & Laughlin Steel Corporation, Pittsburgh. This new plant, to be known as the Gilmore Wire Rope Division of the Jones & Laughlin Steel Corporation, will begin operation about July 1st, 1938. It marks the entry of the corporation into a new line of finished products including wire rope for oil country use, for general construction purposes and for industrial application. The fabrication and sale of the products of the new plant are to be under the direction and supervision of Robert Gilmore, General Manager, whose offices will be at Muncy, Penn. His entire business experience has been in the wire rope field.

Robert Gilmore

Allied Tractor Equipment Company to Handle Buckeye and Emsco Lines

A new corporation, the Allied Tractor Equipment Company, has been formed with headquarters at Findlay, O. Richard A. Wheeler, former sales manager of Emsco's Tractor Equipment Division and Howard K. Biggs, also formerly connected with the same company, will be identified with this new organization. This organization will be the exclusive sales agents for the Tractor Equipment Division of the Emsco Derrick and Equipment Co. of Los Angeles, Calif. Emsco's extensive line of construction equipment includes Emsco cable and hydraulic bulldozers, trail-builders, rippers, scrapers, tamping rollers and power control units. In addition to the Emsco line, the new organization will handle the sales in a number of territories of Buckeye clipper shovels, Buckeye material spreaders and Buckeye road widening machines, products of the Buckeye Traction Ditcher Co., Findlay, O.

▼

Murphy Diesel Appoints Mehler Western District Manager

Murphy Diesel Co., Ltd., of Milwaukee, Wis., announces the appointment of Mr. William Mehler as western district manager. Mr. Mehler has long experience in the Diesel field, and was at one time connected with one of the major fire apparatus builders, who also build Diesels. He served this company for seven years in the capacity of field sales engineer, during which time he covered all of the United States and several foreign countries. He left this company to go into the employ of a large motor products company in the capacity of district sales engineer. He has behind him 20 years' experience in the gasoline and Diesel engine fields, covering both building and sales engineering. Mr. Mehler will be located at 255 10th St., San Francisco, Calif.

▼

International Nickel Expands Technical Field Service

Mr. A .J. Wadhams, Vice-President and Manager of the Development and Research Division, of the International Nickel Company, Inc., New York, has announced the establishment of a new field office located in the Grant Building, Pittsburgh, Pa. The office, which was opened June 1st, is under the direction of Mr. H. V. Beasley, who for the past three years has been attached to the New York office. The main function of this office will be to promote applications of nickel alloy steels and products of the Huntington mill and stimulate interest in nickel cast irons and the use of nickel in non-ferrous alloys. This is the fifth field office opened by the development and research division to give manufacturers in the various industrial districts prompt service in handling their metallurgical problems. Other offices are located in Los Angeles, Calif., Chicago, Ill., Detroit, Mich., and Hartford, Conn.

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LONG RANGE MACHINES

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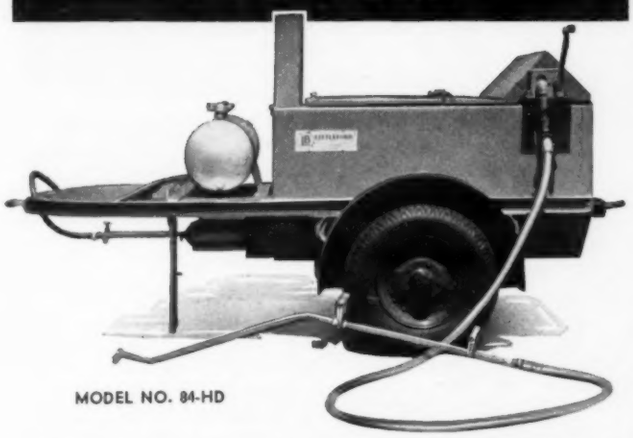

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The Littleford Model No. 84-HD Kettle with the Hand Spray Attachment is the most efficient Road Maintenance kettle on the market today. Has the fastest heating system due to the "Double Heat Circulation" and "V" type separating screen. If you need a tar or asphalt kettle, compare the No. 84-HD from the standpoint of engineering design, appearance, workmanship, etc. You are sure to order this Heavy Duty Littleford Kettle.

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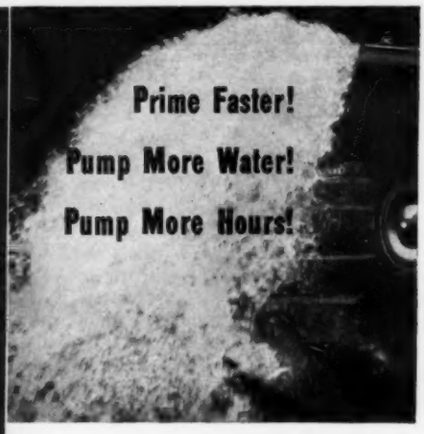

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Only in a Jaeger do you get the Patented Priming Jet for fastest known 100% automatic prime, Patented Lubri-Seal for long-life, perfect sealing, Patented Self-Cleaning Shell and Jaeger Open Impeller for handling dirty water in maximum volume, without clogging or a sign of wear, thru thousands of hours of heavy service. Jobs are safer, dewatering costs lower with a Jaeger. Get our Catalog and Prices.

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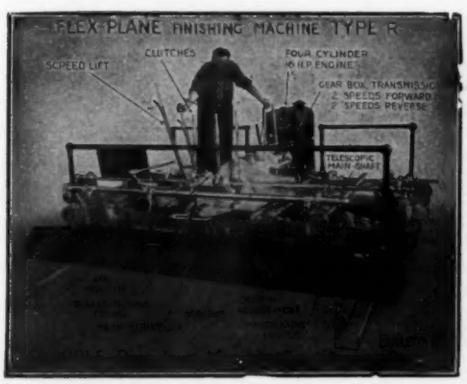
Did You Know That—

ROME'S FIRST GREAT ROADS WERE BUILT BY THE SOLDIERS OF THE LEGIONS, WHO WERE GIVEN THIS TASK DURING PEACE TIMES TO KEEP THEM FROM HATCHING MUTINOUS PLOTS.

"WHEN IN CANADA"



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FLEXIBLE ROAD JOINT MACHINE COMPANY
WARREN, OHIO

E. D. ETNYRE & CO. CELEBRATES FORTIETH ANNIVERSARY

E. D. Etnyre & Co., Oregon, Ill., prominently identified with the manufacture of road and street building and maintenance machinery is now celebrating its fortieth anniversary.

The start of E. D. Etnyre & Co., was a most humble one. The late E. D. Etnyre, who passed on in 1933, first started as a manufacturer of watering tanks for livestock on farms. This, he continued for a number of years, back in the "good old horse and buggy days," when dust was a couple of inches thick on country roads and on most city streets. He didn't like "eating this dust" in his travels and decided to do something about it. So he pioneered and built his first horse-drawn "street sprinkler,"—a water-tank mounted on a lumber wagon, which sprinkled water, by gravity, to "lay the dust" on streets and roads. Then, in 1898, he built his first factory at Oregon, Ill., his home, where the Etnyre's were pioneer settlers in earlier history of the beautiful Rock River Valley, now famously known as the "Hudson of the West."

Visioning the great future ahead for road and street machinery, E. D. Etnyre concentrated upon developing his street-sprinkler and he also originated and pioneered his first "road-oiler," the first one of which was also horse-drawn, mounted on a steel-tired lumber wagon frame.

Then came the early days of "hard roads" and "hard pavements," which needed oiling and flushing. The automobile was then showing that it was destined to revolutionize transportation and bring about road and street building and maintenance that has become one of the biggest industries of the country. Orders for Etnyre road oilers and street sprinklers started coming from all parts of the country. The business of Etnyre was under way.

In 1910, George M. Etnyre, present head of the company, and eldest of the five Etnyre sons, joined his father. Production was entered into in earnest. The business grew and grew. Manufacturing facilities were increased steadily. A new and greatly enlarged factory was built. More workmen were added. The street "sprinkler" was developed into the modern, motorized Etnyre sanitary street flusher. The "road oiler" grew, step by step, into the Etnyre "blacktopper" distributor, used in applying asphalt, road-oil, tar and emulsion in present-day bituminous road construction. A New England branch was opened at East Cambridge, Mass. A New York sales and service office was established. Dealers were appointed in various states throughout U. S. A., in Canada, Mexico, Cuba, South Africa, various South American countries, Europe and Australia. The business of Etnyre was not only nation-wide,—it spread to all parts of the world. A significant highlight in Etnyre history was the shipment of a whole "trainload" of Etnyre distributors to Russia.

As the business continued to grow, George M. Etnyre further expanded manufacturing facilities, brought in skilled engineering. Always the objective was to build the best of the highest quality materials and parts. It has been the Etnyre policy to build the greatest service and performance into distributors and flushers, knowing that the real cost to the owner and user would be determined, not by the purchase price, but rather by the years of service rendered. Etnyre originated and pioneered many of the outstanding features found in distributors and flushers today. One of the most prominent of these is the Etnyre "non-drip, full length circulating spray bar," used on their blacktopper distributors.

A few years later, Robert, Horace and Edward A. Etnyre joined the company. In one way, the Etnyre business is quite a "family affair" and it is significant in the success of the company that every important phase and step of manufacture and service is personally supervised by some one of the Etnyre brothers. In fact, you'll see them, in the factory every day, actually building distributors and flushers, working alongside the workmen who have been with them for many years, specializing in this all important manufacture. Consequently their manufacturing efficiency has been developed to the highest degree and practically every part of an Etnyre distributor or flusher, outside of engines, is built in their factory; virtually "custom-built" for every job.

FOUNDER AND EXECUTIVES OF E. D. ETNYRE & CO.

E. D. Etnyre

George M. Etnyre

Robert D. Etnyre

Horace H. Etnyre

Edward A. Etnyre

The late E. D. Etnyre founded E. D. Etnyre & Co., in 1898, *40 years ago. He passed on in* 1933. *Present heads of the company are George M. Etnyre, Sec'y-Treas., and General Manager; Robert D. Etnyre, President and Superintendent; Horace H. Etnyre, Vice-President and Production Manager; Edward A. Etnyre, Vice-President in Charge of Service. The company is located at Oregon, Ill., and manufactures "Blacktopper" bituminous distributors and Sanitary Street Flushers.*

It is interesting and inspiring to visit the "busy Etnyre beehive" as this writer has done and see these "rigs" as the workmen call them, in all sizes, from 400 to 3,000 gals. tank capacity sizes, being mounted on every known make of motor truck and trailer. These are being shipped to road contractors, highway departments and street-cleaning departments of cities throughout U. S. A. and foreign countries. Here we see, as typical examples, 12 Etnyre distributors on their way to South Africa, 11 Etnyre flushers for South America, a 3,000 gal. job for New York state, a modern new "streamline" flusher for our largest metropolitan city, another for a small community of three thousand, out in the Middle-West. Etnyre distributors of every size going to road contractors and highway departments.

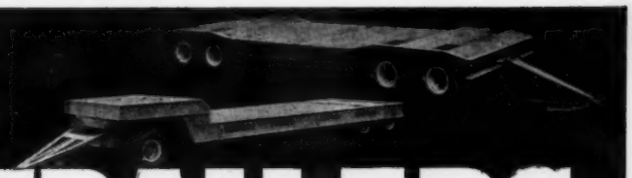
So, as E. D. Etnyre & Company reaches its fortieth birthday, its sales also are the largest in the company's history. What is happening at Etnyre's is probably paralleled by other manufacturers of road and street machinery, which shows plainly, that comparative to other businesses, the "road and street" business, with gigantic appropriations now scheduled to the end of 1941 is a most fortunate one for all of us to be in. That Etnyre blacktopper distributors and street flushers "have made their way by the way they are made" is symbolized in all one sees at the home of E. D. Etnyre & Company, at Oregon, Ill.

▼

National Industrial Advertisers Association to Hold 1938 General Conference in Cleveland

The National Industrial Advertisers Association will hold its 16th annual conference at the Statler Hotel, Cleveland, Sept. 21-23, it has been announced by Stanley A. Knisely, advertising director of the Republic Steel Corporation, who, as vice-president of the association, heads its committee for conference program and arrangements. N. I. A. A., while relatively youthful among national groups of advertising men, has attracted to itself widespread attention on account of its enthusiasm in seeking to establish, standardize and improve modern practices in advertising and selling to the industrial markets. Outstanding, also, is the Association's policy of supporting unequivocally the principle of truth in advertising. Surpassing at the Chicago Convention last September all former attendance records with a registration of almost 800, the enthusiasm with which the members have received early conference notices, leads the Cleveland committee to expect—despite the recession—a still larger attendance this year. Prediction of increased attendance is advanced also by President Frank O Wyse, advertising manager of Bucyrus-Erie Co., South Milwaukee, who characterizes the period since last September as the busiest in the association's history. Early in July, the Conference Program Committee will announce its carefully prepared list of speakers and subjects. The popular clinic idea of discussion meetings

LA CROSSE Heavy Duty TRAILERS



The most complete line on the market. Capacities, five to two hundred tons. Four to sixteen wheels. Two to eight axles. They are built to take the heaviest loads safely, and with the least damage to road beds. Write today. Just tell us what you have to move.

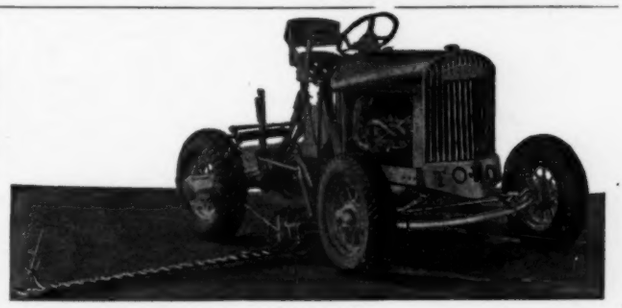
THE LARGEST TRAILER IN THE WORLD IS A LA CROSSE !

LA CROSSE TRAILER & EQUIPMENT CO., LA CROSSE, WIS., U.S.A

DIVISION OF LA CROSSE BOILER CO.

Did You Know That—

ONE OF THE FIRST JOBS ASSIGNED TO LONDON'S MEDIAEVAL "COMPANY OF PAVOIRS," IT APPEARS, WAS TO DRIVE THE PIGS OFF THE STREETS, REMOVE THE FILTH FROM IN FRONT OF BUILDINGS AND LAY A PAVEMENT OF STONES IN CERTAIN SPECIFIED PLACES. THIS HAPPENED IN ABOUT THE YEAR 1302.



NOW!

Built For Highway Mowing
TORO ROUGHMASTER

The need of heavy, cumbersome farm or industrial tractors weighing upwards of three thousand pounds is over as far as mowing is concerned.

Note these specifications—

- a wheel base of only 71 inches.
- a turning radius of 6¾ feet.
- a speed range up to 15 miles per hour.
- a new improved sickle bar with a cutting range from 45° above to 40° below horizontal.
- controls that anyone can drive without special training.
- a normal life of ten years or more.
- a common sense low price.

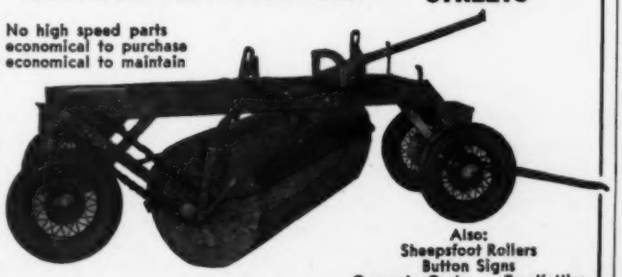
There is a tremendous interest this year in Highway Mowers and the Roughmaster is the answer to the many requests for a light, strong, easily handled machine, and at a price that every State and County can afford.

Send for Interesting Circular

TORO MANUFACTURING CORPORATION
Minneapolis Minnesota

GRACE SWEEPER FOR ROADS AND STREETS

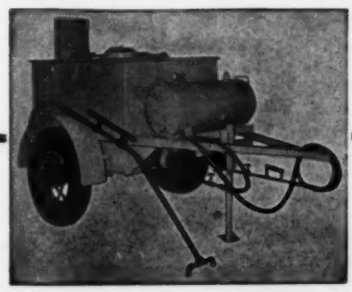
No high speed parts
economical to purchase
economical to maintain



Also:
Sheepsfoot Rollers
Button Signs
Concrete Carts Tar Kettles

Made by

W. E. GRACE MFG. CO.
1822 CHESTNUT DALLAS, TEX.



ASPHALT and TAR KETTLES
FIRE PROOF—OIL BURNING
Hand and Motor driven spray.
Many sizes. Write for catalog.

Elkhart White Mfg. Co. Indiana

will be continued this year with a greater range of subjects, and twice as much time allowed as that which obtained at Chicago in 1937. The demand for exhibit space resulted in more than half the booths being contracted for by the middle of June. The plan to provide as panels judges committees comprising only purchasing agents, engineers, and production men, has created much interest among those who will display examples of their advertising efforts during the conference. The transportation committee will mail to the membership during July a bulletin showing the principal automobile routes, railway, steamer, and airplane lines, and giving information relative to points of interest along the way, as well as scenic and industrial attractions in and near the convention city.

▼

Dr. Walter A. Jessup Elected to Johns-Manville Board to Advise on Social Responsibility

In recognition of the new era of broadened social responsibility upon which American industry is now entering, the directors of Johns-Manville Corporation, New York City, at their June meeting established a policy of widening the board's membership to include not merely stockholders' interests but direct representation for the viewpoint of the general public, Lewis H. Brown, president, announced. To serve this purpose of interpreter of the public viewpoint in correlating modern corporation policies with these newer concepts, the Johns-Manville directors elected to the Board of Directors one of the country's leading educators, Dr. Walter A. Jessup, president of the Carnegie Foundation for the Advancement of Teaching. Dr. Jessup has had a long and distinguished career as an educator, primarily in the Middle West. He was successively superintendent of schools in various Indiana towns, dean of the School of Education at the University of Indiana and at the State University of Iowa, and from 1916 to 1934 president of State University of Iowa. For the last four years he has been president of the Carnegie Foundation. Mr. Brown's letter telling Dr. Jessup of his election to the Board of Directors of Johns-Manville Corporation follows: "No one is more aware than yourself of the profound changes in economic and social thinking that have taken place in this country during the past decade. As a result, American business is today confronted not only with new social responsibilities which it must discharge, but with new concepts that profoundly alter the relationship of business to its stockholders, to its employes, the government and the general public. Determination of industrial policies, as well as consideration of great national economic questions, must more and more include not merely the strictly economic factors on which businessmen are accustomed to rely, but wholly new elements of great importance. The making of profits is, of course, fundamental to all soundly managed enterprises, but the measure of corporate success goes beyond profits and now includes service to the community and nation as well. The pioneering which you have done in studying the social and economic problems of the teaching profession and your interest and long experience in human development especially qualify you to advise industry as it assumes these new and larger responsibilities. May I express my own deep personal satisfaction and the gratification of the entire Board of Directors that you are to assist Johns-Manville in this particular field of service."

▼

Bucyrus-Erie Appoints Clapp Machinery Co. as Distributor

The Clapp Machinery Co., Groton, N. Y., has been appointed distributor for county and township sales in the central portion of New York by the Bucyrus-Erie Co., South Milwaukee, Wis. The new distributor will handle a complete line of Bucyrus-Erie shovels, draglines, clamshells, and lifting cranes ranging from ⅜ to 2-yds. in capacity. The Clapp Machinery Co. will work with the cooperation of the Bucyrus-Erie branch office, suite 3627, 30 Rockefeller Plaza, New York, N. Y.

▼

Smith Appointed Chief Chemical Engineer of Barber Asphalt

Howard V. Smith, of El Dorado, Kan., has been appointed chief chemical engineer of the Barber Asphalt Corporation in charge of the company's technical department, James E. Auten, president, has announced. For the last eleven years Mr. Smith has been assistant superintendent of the El Dorado refinery of the Skelly Oil Co. He is a graduate of the department of chemical engineering of the University of Kansas. J. Strother Miller, Jr., formerly director of the technical department of the Barber Asphalt Corporation, has been advanced to be technical adviser to the company.

▼

Reynolds & Son Appointed Distributor for Bucyrus-Erie

Reynolds and Son, Inc., Barre, Vermont, has been appointed distributor for the entire state of Vermont and Grafton and Sullivan Counties in New Hampshire by the Bucyrus-Erie Co., South Milwaukee, Wis. This new distributor handles the complete line of Bucyrus-Erie shovels, draglines, clamshells, and lift cranes, ranging from ⅜ to 1¼ yd. sizes. Reynolds and Son, Inc., works with the cooperation of the Bucyrus-Erie branch office, suit 3627, 30 Rockefeller Plaza, New York, N. Y., together with the Bucyrus-Erie branch office located at 240 N. Beacon St., Boston, Mass.

▼

Turbine Pump District Representative Appointed by Roots-Connersville

J. B. Trotman, manager of the turbine pump division of the Roots-Connersville Blower Corp., Connersville, Ind., has announced appointment of district representatives for the distribution of turbine pumps, as follows: Arthur W. Schuster, 1025 Granite Bldg., Rochester, N. Y., for the ten counties in the west central part of the state which lie between Lake Ontario and the Pennsylvania line. John B. Foley, Jr., 249 Erie Blvd. West, Syracuse, N. Y., is to cover the northeastern section of New York state lying east of the Rochester territory and north of the metropolitan area. F. S. Salchenberger, 211 Wacker Drive, Chicago, Ill., will call upon the pump trade in the northeastern corner of Illinois, as well as three counties in Indiana adjacent to Chicago. Roots-Connersville maintains its own branch office at 140 South Dearborn St., which is to remain in active charge of the sale of gas pumps, blowers, meters, vacuum pumps, cycloidal rotary pumps, and other products, except turbine pumps. B. J. Walter, 315 W. Woodbridge St., Detroit, Mich., will be in charge of turbine pump sales in the southeastern section of the state of Michigan. A. G. Bradbury, 211 Curtis Bldg., Detroit, who has been representing Roots-Connersville for several years, continues in charge of the sales of all products, other than the turbine pumps, in the greater Detroit area.

▼

Announce New General Manager of Fairbanks-Morse Beloit Works

A. E. Ashcraft, Fairbanks, Morse & Co., Chicago, vice-president in charge of manufacturing, has announced the appointment of A. C. Howard to the position of general manager of the company's Beloit, Wis., plant. This position formerly was held by Mr. Ashcraft in addition to his executive control of all Fairbanks-Morse factories in the United States and Canada. Mr. Howard has been assistant general manager of the Beloit plant for six years. His association with the company began 22 years ago when he was employed as an inspector at the Canadian Fairbanks-Morse Co., Ltd., Toronto factory, which was then engaged in the manufacture of ammunition for the British Government. He subsequently served as general manager of other Fairbanks-Morse factories, both in the United States and Canada.

▼

Marvel Appointed Manager of Tube Sales for Timken

The Timken Roller Bearing Co., Canton, O., announces the appointment of David T. Marvel as Manager of Tube Sales. He will have full charge of the sale of all forms of Timken Seamless Steel Tubing. His headquarters will be at the main office in Canton, O.

▼

M. K. Mellott & Co. Succeeds Mellott & Snyder

M. K. Mellott, until May 10, 1938, engaged in partnership with George H. Snyder in the firm of "Mellott & Snyder," Industrial Publicists, has purchased all other interest and ownership in the company. Beginning July 1, 1938, the firm will be known and registered as "M. K. Mellott & Company." The firm of "M. K. Mellott & Company" assumes all the contractual rights and obligations of the Mellott & Snyder Company, and is prepared to service its clients without change or interruption.

Here Traffic moves in the best of circles

Curbing top of Atlas White portland cement used in Dillons Corner Traffic Circle, Narragansett, Rhode Island. Job placed by Rhode Island Dept. of Public Works. Curbing manufactured by Nelson Cement Stone Co., E. Braintree, Mass. General Contractor, John J. McHale & Sons, Inc., Pawtucket, R. I.

Traffic circles of Atlas White curbing require no maintenance—no repairs or replacements

THIS corner is well-engineered from two standpoints—safety and economy.

Curbing top is of Atlas White portland cement—easy to see, and permanently white. Painting will never be necessary. Moreover, repairs and replacements will not be required. These money-saving characteristics of Atlas White portland cement concrete have demonstrated to many highway officials that Atlas White curbing—and markers—actually pay for themselves within a few years.

Atlas White curbing and markers are easily, quickly placed. Neither specially trained labor nor costly equipment is needed. They can be made "on location"—or pre-cast in sections indoors and moved to the job. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), 208 South La Salle Street, Chicago.

M-22

ATLAS WHITE PORTLAND CEMENT FOR MARKERS AND CURBS

ROADS and STREETS

With which have been merged GOOD ROADS and ENGINEERING & CONTRACTING

Published Monthly by
GILLETTE PUBLISHING COMPANY
330 South Wells Street
CHICAGO, ILLINOIS

THIS MAGAZINE IS DEVOTED TO
Design, Construction and Maintenance of Highways, Streets, Bridges and Grade Separations

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Gillette also publishes
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WATER WORKS & SEWERAGE
SPORTING GOODS JOURNAL
MIDA'S CRITERION
OIL & SOAP

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DO YOU KNOW THAT— 14-73

WRITE for our new circular showing illustration and description of Olsen Special Bench Type Compression Testing Machine. It is designed especially for testing 2" x 4" cylinders and 2" x 2" cubes. The machine is hydraulic, having two gauges, one to half and the other to full capacity. Capacity ranges of from 20,000 to 80,000 lbs.

TINIUS OLSEN TESTING MACHINE COMPANY
500 North Twelfth St. Philadelphia, Pa.

Aeroil
ROAD CONSTRUCTION EQUIPMENT
ASPHALT HEATING KETTLES, EMULSION AND CUTBACK SPRAYERS • SURFACE HEATERS
TOOL HEATERS • LEAD MELTING FURNACES
WEED BURNERS • BURNERS for ROAD OIL TANKS

AEROIL BURNER COMPANY, INC.
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